Post-Concussion Syndrome: Examining a Controversial Diagnosis

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OUTCOMES

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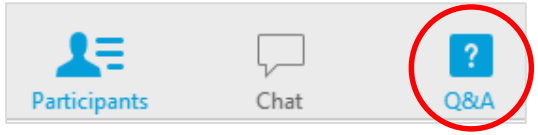

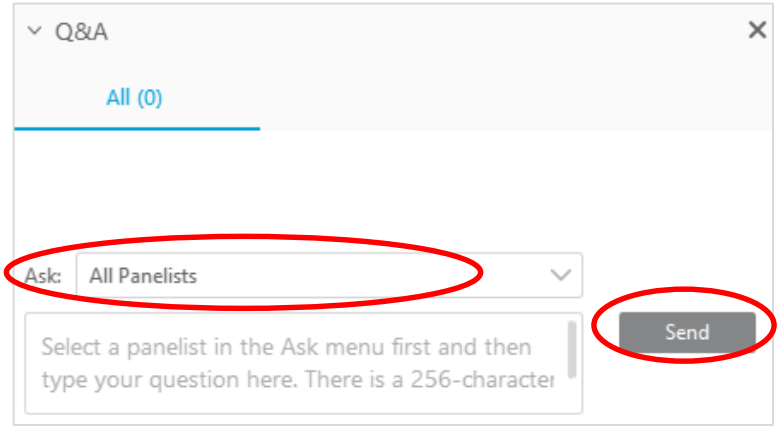

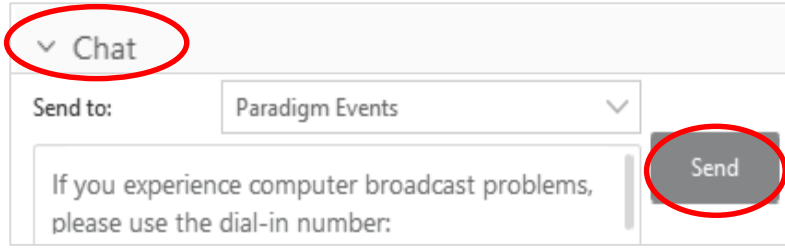

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Today's Speakers

M. Elizabeth Sandel, MD
Paradigm Medical Director

- Specializes in physical medicine and rehabilitation and brain injury medicine
- Holds an academic appointment at the University of California/Davis, School of Medicine
- Champions expansion of brain injury and other rehabilitation programs in health systems in Pennsylvania, New Jersey and California

Steven Moskowitz, MD
Paradigm Senior Medical Director

- Leads Paradigm's pain program
- Physiatrist with 30 year experience chronic pain, neurological rehabilitation
- 30 years experience in managed care and program development
- Certified in Managed Care Medicine

Overview

Concussion Conundrum

Why is this a complicated diagnosis?

- Often confounds biomedical approaches to treatment
- The science is still unclear
- The healthcare system can make the condition worse
- A ***concussion*** is a mild brain injury with numerous subjective neurological symptoms and pain
  - "Mild"
  - "Subjective"

- ***Post-concussion syndrome:*** concussion symptoms that fail to resolve quickly
  - Point at which concussion becomes PCS is blurry
- A systematic approach is needed
  - Objective measurement
  - Clarification of diagnosis
  - Education and restorative therapies
  - Psychosocial support and reassurance

Today's Learning Objectives

Our conversation centers on four primary goals.

1. Define the ***terms***: concussion, mild brain injury, and post-concussion syndrome (PCS).
2. Review the ***epidemiology*** of these disorders, including major causes and prognoses.
3. Identify ***other conditions*** that often accompany PCS and make diagnosis and treatment challenging.
4. Describe ***care management strategies*** that lead to the best outcomes for patients with PCS.

Defining The Terms

Concussion, mild brain injury, and post-concussion syndrome

Concussion Is Now Acknowledged as a Mild Brain Injury

Changes in terminology

Mild Brain Injury Has Certain Characteristics

Current CDC definitions

	TBI SEVERITY		
Criteria	**Mild**	**Moderate**	**Severe**
Structural Imaging	Normal	Normal or abnormal	Normal or abnormal
Loss of consciousness	<30 minutes	30 minutes to 24 hours	>24 hours
Post traumatic amnesia	0–1 day	>1 and <7 days	>7 days
Glasgow Coma Scale score (best available score in 24 hours)	13–15	9–12	3–8
Abbreviated Injury Scale score: Head	1–2	3	4–6

Source: Brasure et al., 2012

Sports-Related Concussion: The Berlin Consensus Statement, 2017

"Among the most complex injuries to diagnose, assess and manage."

- ***Cause***: direct blow to the head, face, neck, or elsewhere on the body (impulsive force transmitted to the head)
- Functional disturbance (not structural); sequential course
- +/- LOC; may evolve; short-lived impairment of neurological function; resolves spontaneously

But ... symptoms may be prolonged…

Source: McCroy P, et al. Consensus Statement on Concussion in Sport: 5th International Conference in Sport in Berlin, October, 2016. *Br J Sports Med,* 2017;51:838-847.

Institute of Medicine's Conclusions: Sports Concussion

- ***Subjective*** symptom-based definitions
- ***Variations in terminology*** (concussion vs. mTBI) and definitions
- ***Evolving descriptions*** of severity (e.g., grading scales, simple vs. complex)
- ***Lack of reliable biomarkers***

Reviewing the Epidemiology of Concussion

Increased incidence or increased diagnosis? Maybe both?

NPR-Truven Poll - 2016

- ***25% of Americans*** reported having had a concussion at some point in their lives
  - Over 51% said they had more than one concussion
  - 79% had sought medical treatment after a concussion
- Of those who had at least one concussion, ***29% said they have suffered from long-term effects***, most commonly headaches

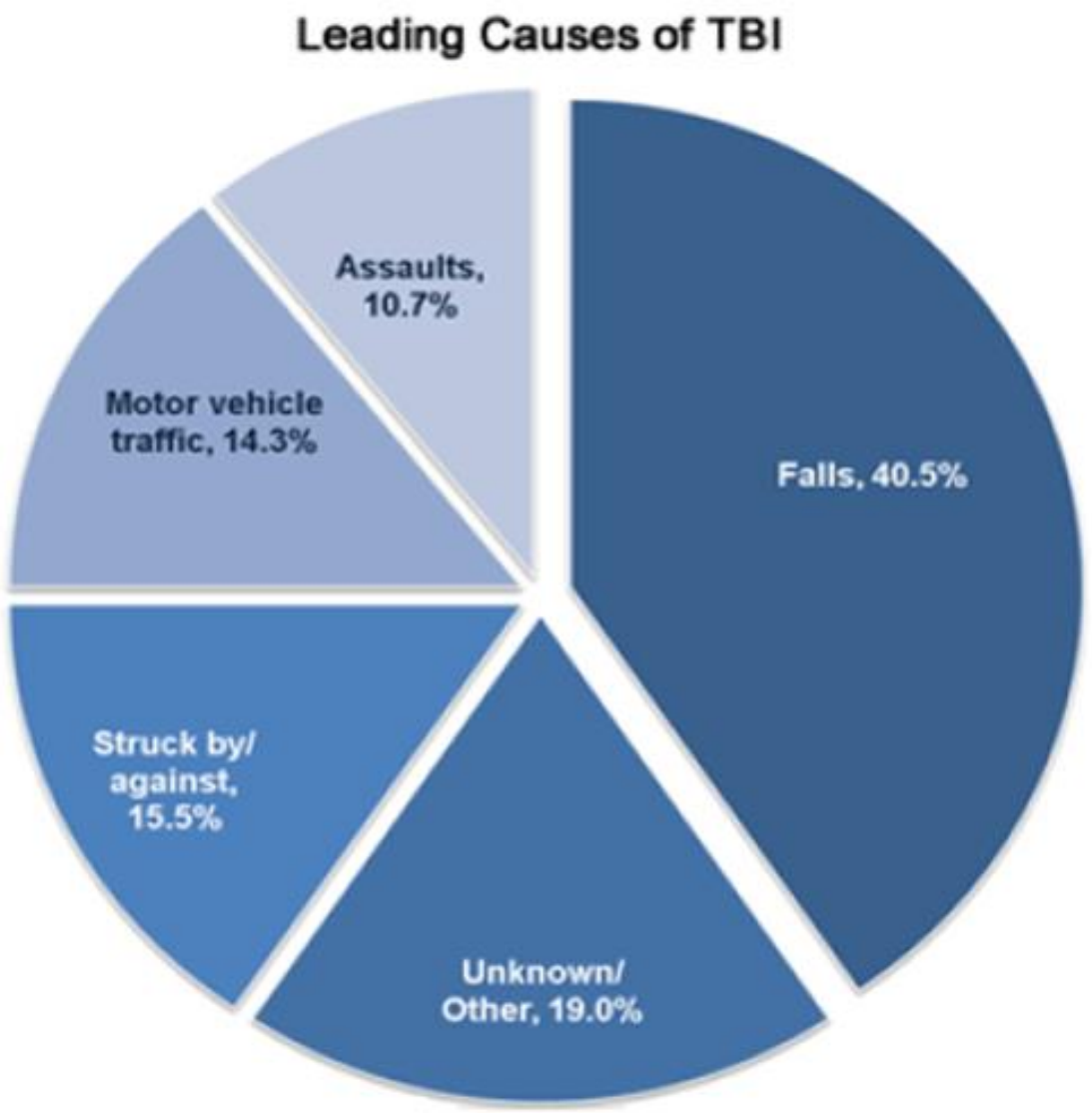
Blue Cross-Blue Shield Study - 2016

Based on claims data from 2010 through 2015

- ***Concussion diagnoses increased 42%,*** with variation in rates of diagnosis based on geography
- The percentage of patients diagnosed with PCS ***nearly doubled during the study period***
- ***Patients ages 10-19*** showed no difference in the rate of diagnosis of post-concussive syndrome
- ***Females ages 20-64*** who were diagnosed with concussion were nearly 60% more likely to be diagnosed with PCS

Falls: #1 Cause of TBI (CDC data)

- 55% of TBIs among children up to age 14 caused by falls
- More than 81% of TBIs in adults aged 65 and older caused by falls



Work-Related TBI

- ***45-50%*** of all TBIs are work-related
- ***High-risk occupations***: construction; landscaping; transportation
- ***Older workers*** - anecdotal data
- 37 cases per 100,000 for military employees
  - 57% related to transportation
- 15 cases per 100,000 for civilians
  - 50% are because of falls

Was There a Brain Injury and If So, How Severe Was It?

Pathologists and clinicians have measures, but we lack definitive biomarkers

Concussion: First Description in Medical Literature

Abu Bakr Mohammad Ibn Zakariya Razi or Rhazes (AD 865– 925), renown Persian physician, first described concussion and established the concept of a **transient**, **physiological** abnormality or the brain, i.e., **no structural evidence of injury.**

Source: McCrory P, Berkovic S. Concussion: Historical development of clinical and pathophysiological concepts and misconceptions. Neurology 2001;57:2283-9.

Neurologist Henry Miller: "Accident Neurosis"

He described patient behavior that he called ***"dramatization of symptoms,"*** such as a patient "slumping forward with head in hands during the consultation, requesting a glass of water."

"I had long regarded this last as a pathognomonic sign of accident neurosis, but I understand that it is often seen in women requesting termination of pregnancy on psychiatric grounds."

Among his conclusions was that accident neurosis was cured for most of the population after a legal settlement.

Source: Miller, H. Accident Neurosis. Br Med J 1961;1(5230):919-925.

What Happens to the Brain?

We understand a lot but clinical trials to improve outcomes have largely failed.

Biomechanics of Brain Injury

Deformation Forces on the Brain

Shear is the most important cause of diffuse axonal injury.

- ***Compressive:*** Squeezing
- ***Tensile:*** Stretching
- ***Shear:*** Distorting
  - Produced when tissue slides over other tissue
  - Inertial or acceleration/deceleration effects
  - Diffuse axonal injury likely the main pathology in mild TBI or concussion

Neuroimaging and Mild TBI

- 3-10% of mTBI patients (GCS = 13-15) have ***abnormal CTs*** (of those scanned in EDs) – National Center for Health Statistics

- 25% of patients admitted to EDs with mTBI diagnosis ***did not get a CT scan***
  - When scanned, 16-21% had abnormal CTs (Iverson, Brain Injury, 2006)

- ***MRI***: 10-57% positivity in mild TBI (Bazarian, Academy of Emergency Medicine, 2006)

Acute Concussion: A Literature Analysis

A reasonable diagnostic criteria or not?

- Observed and documented ***disorientation or confusion*** immediately after the event
- ***Impaired balance*** within 1 day after injury
- ***Slower reaction time*** within 2 days after injury
- And/or ***impaired verbal learning and memory*** within 2 days after injury

Source: Carney N, Ghajar J, Jagoda A, et al. Concussion Guidelines Step 1: Systematic Review of Prevalent Indicators. Neurosurgery 75:S3–S15, 2014.

Assessments for Acute Concussion

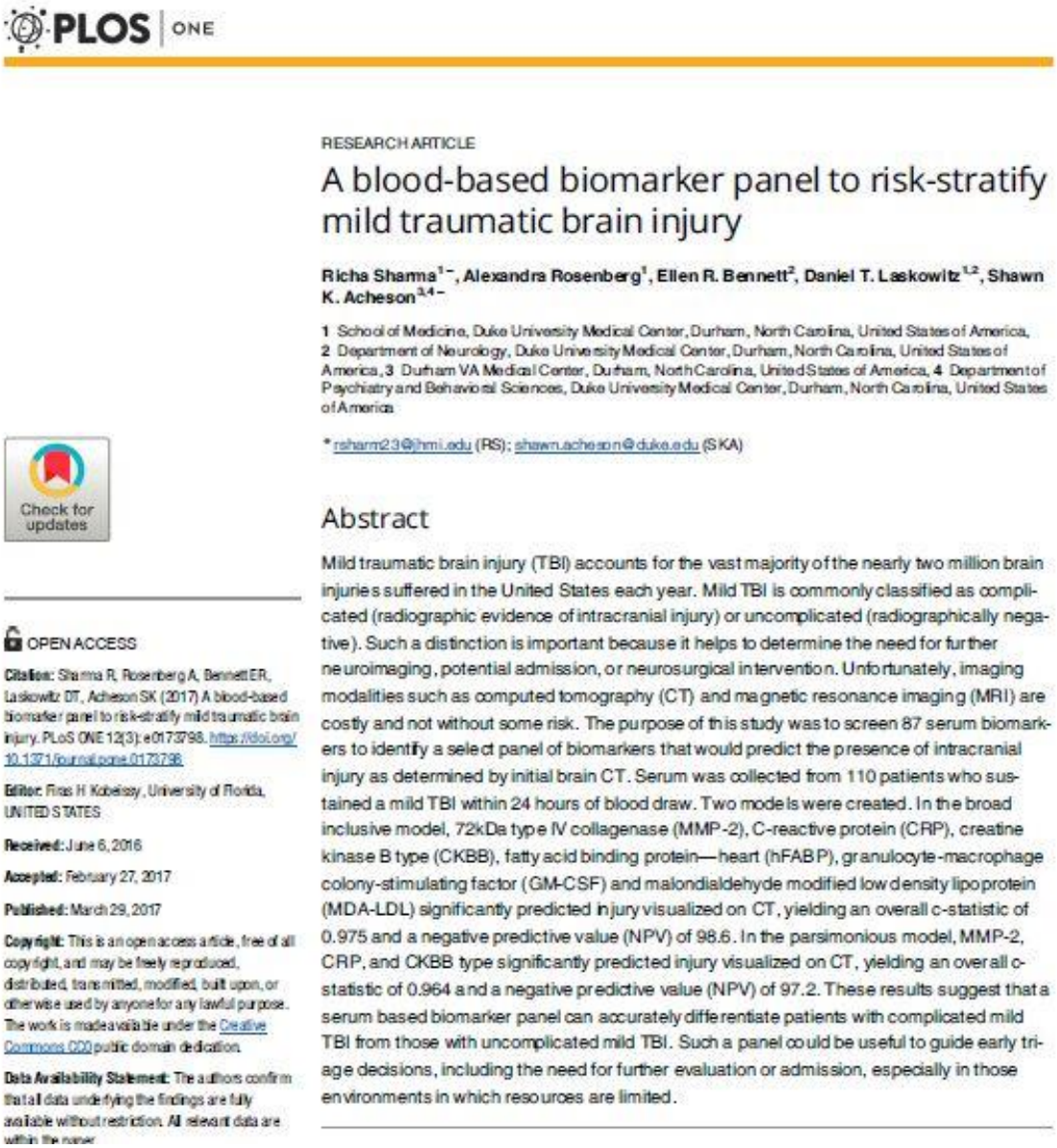
Sports and non-sports concussion evaluations at the sidelines and in the ED and clinic.

Unfortunately, evaluations are often focused on ruling out a surgical lesion with imaging studies (CT), not a more comprehensive evaluation

- **Physical**
  - Balance (BESS); head and neck exam; vestibulo-ocular function (King-Devick; VOMS); Hallpike-Dix
- **Cognitive**
  - SCAT-5; ImPACT; MoCA
- **Emotional**
  - PHQ-4 or -9; PTSD screen

TBI Biomarkers – Awaiting the Research

"These results suggest that a serum based biomarker panel can accurately differentiate patients with complicated mild TBI from those with uncomplicated mild TBI."



PLOS ONE

RESEARCH ARTICLE

A blood-based biomarker panel to risk-stratify mild traumatic brain injury

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Abstract

Mild traumatic brain injury (TBI) accounts for the vast majority of the nearly two million brain injuries suffered in the United States each year. Mild TBI is commonly classified as complicated (radiographic evidence of intracranial injury) or uncomplicated (radiographically negative). Such a distinction is important because it helps to determine the need for further neuroimaging, potential admission, or neurosurgical intervention. Unfortunately, imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI) are costly and not without some risk. The purpose of this study was to screen 87 serum biomarkers to identify a select panel of biomarkers that would predict the presence of intracranial injury as determined by initial brain CT. Serum was collected from 110 patients who sustained a mild TBI within 24 hours of blood draw. Two models were created. In the broad inclusive model, 72kDa type IV collagenase (MMP-2), C-reactive protein (CRP), creatine kinase B type (CKBB), fatty acid binding protein—heart (hFABP), granulocyte-macrophage colony-stimulating factor (GM-CSF) and malondialdehyde modified low density lipoprotein (MDA-LDL) significantly predicted injury visualized on CT, yielding an overall c-statistic of 0.975 and a negative predictive value (NPV) of 98.6. In the parsimonious model, MMP-2, CRP, and CKBB type significantly predicted injury visualized on CT, yielding an overall c-statistic of 0.964 and a negative predictive value (NPV) of 97.2. These results suggest that a serum based biomarker panel can accurately differentiate patients with complicated mild TBI from those with uncomplicated mild TBI. Such a panel could be useful to guide early triage decisions, including the need for further evaluation or admission, especially in those environments in which resources are limited.

When Concussion Symptoms Remain or Worsen

Why do some patients have prolonged symptoms?

Analyses of PCS

- ***Most are normal/near normal*** 30 to 90 days post-injury. (Carroll et al, 2004; Schretlen & Shapiro, 2003)
- ***5% to 20% have persisting problems.*** *"Miserable Minority"* (Iverson, 2005; Ruff, et al., 1996)
- ***10% remained symptomatic at 1-year*** follow-up. (von Wild, 2008)
- ***9% of athletes did not return to baseline*** after a concussion. (High school athletes suffered the largest deficits post-mTBI.)

Source: Karr JE, et al. The neuropsychological outcomes of concussion: a systematic review of meta-analyses on the cognitive sequelae of mild traumatic brain injury. Neuropsychology 2014;28(3):321–336.

ICD-10: Post-Concussion Syndrome

At least 3 of the following features at 4 weeks or less:

1. **Headache**
2. **Dizziness** (not necessarily true vertigo)
3. **Fatigue**
4. **Irritability**
5. **Difficulty in concentrating** and performing mental tasks
6. **Impairment of memory**
7. **Insomnia**
8. **Reduced tolerance to stress**, emotional excitement or alcohol.

May be accompanied by fear of brain damage, loss of self-esteem, feelings of depression or anxiety. Some patients become hypochondriacal.

Source: http://www.icd10data.com/

Post-Concussion Syndrome: Physical Symptoms

- Smell/taste changes
- Noise sensitivity
- Light sensitivity
- Hearing changes
- Visual disturbance
- Poor coordination
- Fatigue/loss of energy
- Headaches
- Dizziness
- Poor balance
- Vertigo
- Nausea
- Appetite problems
- Sleep disturbance

Source: Cicerone K, Kalmar K. Persistent post-concussive syndrome: Structure of subjective complaints after mild traumatic brain injury. Journal of Head Trauma Rehabilitation 1995;10:1-17.

PCS: Cognitive Symptoms

- ***Memory*** difficulties (inefficiency; working memory deficits)
- ***Attention/multi-tasking*** difficulties
- Slowed information ***processing***
- ***Word-finding*** difficulties
- ***Decision-making*** difficulties

Source: Cicerone K, Kalmar K. Persistent post-concussive syndrome: Structure of subjective complaints after mild traumatic brain injury. Journal of Head Trauma Rehabilitation 1995;10:1-17.

PCS: Emotional Symptoms

- Depression
- Anxiety
- Irritability/anger
- Poor frustration tolerance; “short-fuse”
- Affective lability
- Decreased libido
- Changes in self-image/identity
- Feelings of being overwhelmed

Source: Cicerone K, Kalmar K. Persistent post-concussive syndrome: Structure of subjective complaints after mild traumatic brain injury. Journal of Head Trauma Rehabilitation 1995;10:1-17.

Psych Disorders in mTBI

- 939 persons without history of TBI
- mTBI and prior psychiatric illness - evidence of persisting psychiatric illness
- Among mild TBI subjects without psychiatric illness in the prior year - adjusted RR for any psychiatric illness in the 6 months following = 2.8
- ***Prevalence of any psych disorder at 1 year:***
  - **Mild:** 34%
  - **Moderate/severe:** 49%
  - **Comparison group:** 18%

Source: Fann JR. et al. Psychiatric illness following traumatic brain injury in an adult health maintenance organization population; Arch Gen Psychiatry. 2004;61:53-61.

Post-Concussion Syndrome

- Many studies suggest ***psychological factors*** (e.g., anxiety and depression and PTSD) play a major role in persistent PCS.
- Pain, vestibular, ocular-motor dysfunction and other ***physical symptoms*** have impact on cognitive functioning.
- ***Early education*** about recovery and targeted treatments can decrease symptoms and recovery time.
- Litigation, compensation, malingering, ***secondary gain*** issues may be factors.

A Patient's Perspective

A Med Student and Cyclist With a Concussion and PCS

Photo courtesy Dr. Sandel

A Med Student and Cyclist With a Concussion and PCS

Seth Fischer is a fourth-year medical student at the University of California/Davis School of Medicine. Seth suffered a concussion while riding his bicycle near the UC Davis campus in Sacramento, Calif., in 2015. His **post-concussive symptoms lasted at least a year**.

In an interview with Dr. Sandel, he recounts the **difficulties** he had because of the post-concussion syndrome, and **what he learned** that might be helpful to physicians, other healthcare providers, and to others who suffer a concussion and have prolonged symptoms.

Source: www.elizabethsandelmd.com

PCS Is Not an Easy or Quick Fix: The Patient's Perspective

Quotes from Seth

"It actually changed a lot going to the patient side of things. These kinds of invisible injuries are hard to quantify."

"Six or seven months later I still had neck pain. I didn't know if I was still getting tension headaches or if this was migraine."

"You can ask all the questions you want. The convoluted nature of these injuries is one thing that our profession doesn't understand and one thing that is really hard for the patient to elaborate on. I didn't know what was going on."

Source: http://elizabethsandelmd.com/interviews/cyclist-post-concussion-syndrome/

PCS Is Not an Easy or Quick Fix: The Patient's Perspective

Quotes from Seth

"I learned a lot about how to listen to patients. The chronic nature of injuries, whether it's memory problems or headaches, is a terrible existence. It's something that doesn't go away."

"You might see the patient once every couple of weeks or months and see them progressing. For the patient, it's a slow slog. It's hard to make people understand this."

"With a brain injury it's a whole different game. It's a slow trajectory."

Source: http://elizabethsandelmd.com/interviews/cyclist-post-concussion-syndrome/

Care Management Strategies

Early, expert, comprehensive, targeted, coordinated evaluation and treatment

Symptom Management in Post-Concussion Syndrome

Symptom checklists can be helpful to provide targeted treatment and track recovery.

- ***Physical:*** Pain, headaches, balance, dizziness, vertigo, noise/light sensitivity, sleep disturbances, fatigue

- ***Cognitive:*** Attention/concentration, slow processing of information, inefficiencies, mental fatigue

- ***Emotional:*** Poor frustration tolerance, irritability, decreased libido, anxiety, depression

Care Management of Post-Concussion Syndrome

A multidisciplinary, multifaceted, individualized care pathway that might include ...

- ***Early education*** and reassurance
- ***Physical therapies***
  - Vestibular therapy/Epley maneuver (Vertigo/BPPV)
  - Other physical modalities
- ***Cognitive rehabilitation***; academic re-integration
- ***Vision interventions*** – short-term; home program
- ***Psychotherapy***; cognitive-behavioral approaches; PTSD interventions; medication for mood and sleep
- ***Vocational counseling***, work-hardening; re-Integration

What to Expect from a Neuropsychological Evaluation

- ***Did a TBI occur?*** LOC? PTA? Other cognitive impairment?
- ***Evaluate***
  - Current cognitive status, strengths and weaknesses
  - Pre-morbid vs. injury-related conditions
  - Neurological vs. psychological vs. physical conditions (No direct measures for all behaviors or basis for cognitive or emotional symptoms)
  - Litigation, poor effort, secondary gain, motivation, malingering ?
- Provide ***education*** about symptoms and outcome
- Recommend ***specific treatment*** and management
- Give ***advice*** about return to work or school or driving

A Final Caveat: Our Diagnostic Limitations

We may never be able to determine exactly what is neurological and what is psychological, but outcomes will be determined by a comprehensive approach.

"This study supports an association of TBI, including mild TBI, with the ***subsequent development of neurological and psychiatric illness***."

"While psychiatric symptoms are common in the acute phase after mild TBI and some of these may be short-lived manifestations of the injury, ***others may reflect a more sustained susceptibility to mental illness.***"

"The fact that multiple neurodegenerative and psychiatric diagnoses are associated with the same exposure raises questions about ***possible mechanisms of shared vulnerability.***"

Source: Perry, et al. Association of traumatic brain injury with neurological and psychiatric disease: a metanalysis. J Neurosurg 2016; Vol 124.

Summary

Post-Concussion Syndrome

Take a biopsychosocial systematic approach.

- ***Clarify the diagnosis***
  - Did a concussion occur? Have the symptoms lingered?
  - Are there objective cognitive deficits?
  - Clarify the nature of other symptoms
  - Clarify the nature of psychosocial factors in recovery
- ***Facilitate the appropriate evidence-based treatment***
  - Self-management
  - Graded therapies toward measurable goals
  - Avoid clinics with “chronicity bias”
- ***Psychosocial management***
  - Education and reassurance regarding recovery.
  - Psychosocial support

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https://www.surveymonkey.com/r/postconcussionsyndrome

Tip: If your work computer has blocked Survey Monkey, access the link via your home computer.

Question and Answer Session

Submit your questions in the Q&A panel on the right of your screen.

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