Concussion: Management, Intervention, & Rehabilitation

Nov 13: Concussion Management Update: Recommendations from the Berlin Meeting
Tamara McLeod, PhD, ATC, FNATA

Nov 14: Chronic Post-Concussion Syndrome: Psychological and Cognitive Implications for Treatment
Brady Whetten, PT, DPT, GCS

Nov 15: Concussion: Conditioning the Brain and Body for Return to Sport
Guest Editor: Mike Studer, PT, MHS, NCS, CEEAA, CWT

Nov 16: Concussion and the Older Adult: Does Age Make a Difference?
Debbie Struikema, PT, NCS

Nov 17: The Management of Cervicogenic Pain and Headaches After Concussion
Renée James, MSPT, OCS, CMP and Bailey Denno, PT, DPT

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Chronic Post-Concussion Syndrome: Psychological and Cognitive Implications for Treatment

Brady Whetten, PT, DPT, GCS
Objectives

Upon completion of this course, attending clinician will be able to:

- Describe at least two components of differential testing and at least two evidence based outcome measures that quantify functional limitations in cognition and psychological distress in individuals with post-concussion syndrome.
- Identify at least three appropriate strategies to successfully manage abnormal sensory dominance and autonomic nervous system maladaptation in persistent disability.
- List at least three novel interventions based from evidence-based treatment paradigms that address the complex presentation of the patients.
- Describe at least two case studies presented within this course, of challenging patient presentations to allow for immediate clinical application of the treatment paradigms.

Acknowledgements

- Janene Homberg
- Kenda Fuller
- Mike Studer
- Many patients and their families at NWRA
Concussion

- Complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces
- Often resolves spontaneously
- Reflected in a functional recovery, not structural
- Imaging typically negative
- Majority of concussions not from athletics

- Axonal stretching $\rightarrow$ disruption of neural membranes $\rightarrow$ Potassium and glutamate out $\rightarrow$ influx of calcium $\rightarrow$ Na/K pump needs to work overtime $\rightarrow$ increased energy required $\ldots\ldots$ results in metabolic crisis

Post-Concussion Syndrome (PCS)

- Varying definitions of PCS
- Generally indicates presence of at least 1 sx $>$ 2 weeks post-injury
- 15-25% continue to experience symptoms $>$ 3 months post injury
- PCS refers to somatic, cognitive, emotional, motor, or sensory sx’s ascribed to a concussion or head injury
Predictors of PCS

- Difficult to predict who will have persistent sx’s
- Preinjury psychiatric or other health problems, life stressors
- Concurrent anxiety, depression, posttraumatic stress
- High levels of fear avoidance behaviors in 35% w/ PCS
- 10-15% of high school athletes experience PCS following sports-related concussion (SRC) – Kerr et. al. 2017
  - >10-14 days post injury
  - Presence of cognitive, somatic, and sleep-related symptoms predicted PCS sx’s

Common Symptoms

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<td>Numbness/tingling</td>
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<td>Dazed</td>
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Persistent dizziness causes in Post Concussion Syndrome (PCS)

- Chronic Pain
- Chronic Stress
- Cervical Strain
- Deconditioning
- Pituitary Dysfunction
- Insomnia
- Vestibular Dysfunction
- Oculomotor Dysfunction

**CNS neuropathology**
- Autonomic Dysfunction (cerebral hypoperfusion or attenuated blood flow in the brain)
- Anxiety/Depression
- Post Traumatic Stress Disorder
- Psychosomatic effects (classically conditioned responses)

PTSD & mTBI (Bryant 2011)

- Post-Traumatic Stress Disorder
  - Exposed to event that threatens safety, and respond with fear
  - Report re-experiencing symptom
  - Avoidance symptoms
  - Suffer from marked arousal

- Cause marked impairment to function, present 1 month post injury
Bryant 2011

- “The emerging evidence that PCS is predominantly influenced by post-traumatic stress reactions suggests that addressing these problems may be crucial in alleviating PCS”

Trauma

- “The person experienced, witnessed or was confronted with an event, or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others.” (*DSM-IV*)
- Individual responds with: intense fear, helplessness, horror
- “Trauma is in the brain, not in the experience”
Memories vs sensitizations

- Normal memory
  - Events are remembered as stories
  - Can change over time
  - Do not evoke intense sensations or emotions

- Traumatic sensitizations
  - Immediate sensory and emotional response
  - Knowledge of event may be absent
  - Dissociation

Keys to trauma

- The retention of traumatic procedural memories through fear-conditioning and kindling
- Kindled posttraumatic procedural memories provide repetitive, unconscious cue-related input to fight/flight
- Increased dysfunctional autonomic cycling.
CONDITIONING IN TRAUMA

• Lack of “completion” imprints the conditioned association of the threat:
  - The sensori-motor experience of the body
  - The emotional state
  - The autonomic state of arousal within procedural memory
  - This association leads to fear conditioning, or traumatization

Signs Suggestive of a Traumatic Past

• Tactile defensiveness
• Defensive intellectualism
• Breath alteration
• Boundary rupture
• Self sabotage - Affinity to put themselves in the wrong place at the right time
• Patient initiated termination
Sympathetic: Fight/Flight/Freeze

- Adaptation to emergencies
  - General adaptation syndrome
- Neurons in medulla
  - Cardiovascular
  - Respiratory
  - Gastrointestinal
  - Baroreceptors
- Excitation!!!

PARASYMPATHETIC: Rest and Digest

- Vagal responses
- “Gut feelings”
- Increases: digestion, intestinal motility, fuel storage (increases insulin activity) resistance to infection, circulation to non-vital organs, (skin, extremities...) endorphins, the "feel good" hormones
- Decreases: heart rate, blood pressure, temperature
- Inhibition
Parasympathetic Dominance

• Palpitations, nausea, dizziness, indigestion, abdominal cramping, syncope, diarrhea and incontinence, exhaustion.

• IBS, PMS, colitis, chronic fatigue, ulcers, interstitial cystitis (IC)

• Pelvic floor dysfunction (PFD), orthostatic hypotension, gastric reflux

• Increase in abdominal tension and bloating
Clinical considerations

- These patients do not like change, as with appointments
- Hard to conceptualize: may need to use pictures
- Create safe place in office, calm environment
- Minimal hand gestures, safe body posture

Normal Balance System

[Diagram showing the normal balance system with various components and pathways]
Head trauma

- **Misweighting of sensory information** with heavy dominance on vision and underweighting of proprioception and even reciprocal inhibition of vestibular information
- **Heightened awareness** to motion/destabilizing cues and conscious motor control
- Amygdala Perceives **THREAT** driving increased autonomic dysregulation of sympathetic and parasympathetic responses

Balance system post-trauma

- Vision
  - Cortex/Thalamus
  - Amygdala Perceived threat
  - Vestibular nuclei
  - Cerebellum
- Cortex
  - Heightened awareness
  - Conscious Motor control
- Somatosensory
  - Vestibular
- Brainstem Autonomic control
  - VOR
  - VSR & COR
  - Fight or flight
  - Ocular tilt response
Boundaries

- Small safe world, “invisible but real”
- Collective experiences, positive and negative
- Senses - smell, vision, hearing, vestibular, taste, touch, proprioception and nociception help form these boundaries
  - Eventually tell us where we as a perceptual whole end, and the rest of the world begins
  - Threat, hurt, violence, shame; in a state of perceived helplessness

Regardless of the cause...we need to get them better
Differentiating Subjective Complaints

What is driving the Disability?
Critical components of the dizzy history

- **Quality**: Dizziness vs vertigo vs unsteadiness
- **Associations**: stress, marked with FEAR/worry
- **Triggers**: what provokes the symptoms?
- **Duration**: How long does it last?

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Dizziness Handicap Inventory (DHI)

- 25 item “Self perceived handicap”
- Grouped “because of your problem...
  - Function - What is it difficult?
  - **Emotion - Do you feel?**
  - Physical - What increases your symptoms?

- Mild – 16-34
- Moderate – 36-52
- Severe – 54+
Situational Vertigo Questionnaire (SVQ)

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>N.T.</th>
<th>Not tried</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>Very slightly</td>
<td>Somewhat</td>
<td>Quite a lot</td>
<td>Very much</td>
<td>N.T.</td>
<td>Not tried</td>
</tr>
</tbody>
</table>

- Riding as a passenger in a car on a straight, flat road
- Riding as a passenger in a car on winding or bumpy roads
- Walking down a supermarket aisle
- Standing in a lift while it stops
- Standing in a lift while it moves at a steady speed
- Riding in a car at a steady speed
- Starting or stopping in a car
- Standing in the middle of a wide open space (e.g., large field or square)
- Sitting on a bus
- Standing on a bus
- Heights
- Watching moving scenes on the T.V. or at the cinema
- Travelling on escalators
- Looking at striped or moving surfaces (e.g., curtains, Venetian blinds, flowing water)
- Looking at a scrolling computer screen or microfiche

Visual vertigo

- **Visual Vertigo Analog Scale (VVAS)**

  - Walking through a supermarket aisle
  - Being a passenger in a car
  - Being under fluorescent lights
  - Watching traffic at a busy intersection
  - Walking through a shopping mall
  - Going down an escalator
  - Watching a movie at the movie theater
  - Walking over a patterned floor
  - Watching action television
Positive Affect Negative Affect Scale (PANAS)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>very slightly or not at all</td>
<td>a little</td>
<td>moderately</td>
<td>quite a bit</td>
<td>extremely</td>
</tr>
</tbody>
</table>

- interested (P)
- distressed (N)
- excited (P)
- upset (N)
- strong (P)
- guilty (N)
- scared (N)
- irritable (N)
- alert (P)
- ashamed (N)
- inspired (P)
- nervous (N)
- determined (P)
- attentive (P)

Significant Anxiety
Negative Scale > 29.9

Significant Depression
Positive Scale < 22

Hospital Anxiety and Depression Scale (HADS)

<table>
<thead>
<tr>
<th>ID</th>
<th>A</th>
<th>D</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I feel tense or “wound up”</td>
<td>I feel as if I am wound down:</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Most of the time</td>
<td>Never all of the time</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>A lot of the time, occasionally</td>
<td>A little of the time, occasionally</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>A lot of the time</td>
<td>Most of the time</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I just can’t get anything to relax in my body</td>
<td>I feel as if I allow myself to relax</td>
<td></td>
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</table>

I get a sort of heightened feeling as if something is almost to happen. |

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<th>D</th>
<th>A</th>
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<tr>
<td>1</td>
<td>I can laugh and even the heavy side of things</td>
<td>I have lost interest in my appearance:</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>At times, I actually laugh</td>
<td>I have lost interest in my appearance:</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>At times, I actually laugh</td>
<td>I feel as if I lack physical attractiveness</td>
<td></td>
</tr>
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<td>4</td>
<td>At times, I actually laugh</td>
<td>I am not as concerned with appearance as I was</td>
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Tich the box beside the reply that is closest to how you have been feeling in the past week. Don't take too long over it, you're replacing your invariable to harm.

Please check you have answered all the questions.

Scores:
- Anxiety (A)
- Depression (D)
- Normal
- Borderline abnormal (borderline case)
- Abnormal (scale)

11/14/2017
Evaluation general guidelines

- Unusual balance performance
  - Increased upper body sway reactions, out of proportion to level disturbance
  - Adopting postures that require increased balance e.g. Momentary single leg stance exposures, narrowed heel-toe walking

- Normal performance but with poor tolerance

- Level of disability doesn’t match clinical findings/impairments

- Aphysiologic/Inconsistent Performance

- Don’t over read non-localizing findings clinical findings IF HISTORY doesn’t support

Evaluation Specifics

- Oculomotor Testing (Quality and Tolerance)
  - Smooth, Saccade, Convergence, OPK, VOR cancellation, Cover/uncover or Maddox Rod

- Visual Motion Sensitivity
  - Subjective intolerance: oculomotor testing & CTSIB (including conditions 3/6)
  - Subjective report and questionnaires

- Motion Sensitivity Testing (MSQ)
  - Positioning and positional testing
Management of PCS

- Identify what is driving the persistent symptoms
- Critical to get that under control first
- Look at the whole person
  - “It is more important to know what sort of a patient has a disease, than what sort of disease a patient has.”
  - Sir William Ostler 1911
- Task specificity and principles of vestibular rehabilitation are still critical
RELAXATION TRAINING: ANS Calming

- Guided Relaxation/mindfulness training/experiencing
- Grounding (G)
- Sound (S) Quieting the Mind
- Breathing (B) training awareness
  - Mindful, diaphragmatic, resonant frequency breathing
- Body Scan: Muscle tension awareness
- Imagery
- Assigned practice 10-40 min daily and frequent GSB during day
  - Podcasts, Scripts, Online, Apps

Relaxation/mindfulness resources

- Book: The Mindful Way through Depression by J Mark G. Williams
  - CD included with Jon Kabat-Zinn
- Apps
  - “Calm : 7 free sessions that can be repeated different length, subscription needed to fully use the program
  - “Insight Timer”: Free guided meditations, music tracks, talks and courses
- Online Resources:
  - Martin Rossman: https://thehealingmind.org
  - Tara Brach: https://www.tarabrach.com
Focus on breathing pattern

- Oxygenation of the organism can be determined by monitoring how long the patient can pause their breath w/o stress.
- 20-60 Sec in health
- 5 Sec in diseased states.
- Breathing can be trained!!!
Breathing

- Oxygen is a natural anti-inflammatory
- High blood pressure can be related to poor breathing
- Sleep disturbance when breathing is not normal
- Increase in upper quadrant tension
- Modulates anxiety/relaxation

Mechanoreceptors

- Touch
  - Cutaneous stimulation
- Pressure
  - Weighted blanket, weights on/through shoulders
- Temperature
  - Neutral Warmth
- Sound
  - Inner voice, language and music
Habituation=Guided neuroplasticity

- Habituation WITH emphasis on control/groundedness
  - Small doses, long rest periods
  - Calm fight/flight responses
  - Primary goal is control of symptoms
  - Watch for inefficient stabilization/high threat behaviors

- ID & Rx patient’s exact trigger
  - Progress intensity as tolerance builds & autonomic reactivity decreases
  - GOAL: reduce sensitivity to head/visual motion intolerance
  - 3-5 repetitive motions (2-4 minutes), rest, repeat 3 sets, TID
  - Visual tracking and or slow VORx1 in sitting (supine if needed) 10-20 seconds up to 1-2 minutes, TID
  - Add into standing & gait: 90, 180, to 360 degree turns independently then within gait

NEUROPLASTICITY AND HEALING TRAUMA

- Therapy rewires the brain and takes time
- Regulatory skills restore homeostasis, reduce serum cortisol, restore the hippocampus
- Mindfulness and attunement skills inhibit the amygdala, enlarge frontal cortex
- Fear extinction of traumatic memory cues inhibits kindling
- Empowerment replaces helplessness
- Increased frontal cortex, hippocampus in meditation
**Therapeutic Alliance**

- “The therapist ability to form an alliance is possibly the most crucial determinant of his effectiveness.”
  - Luborsky et al (1985)

- Therapeutic alliance: subtle, dynamic relationship between patient and therapist. Not an intervention or technique, rather vehicle within which therapeutic process is facilitated.
  - Schore

**Therapeutic Presence**

- Safety
- Establish a non Threatening Presence
- Be able to Allow the Client to Downregulate
- Meet all levels
- Create a sense of security, normalize their experience
PCS Autonomic Dysregulation

- Pain management
- Cervical /Headache protocols
- Sleep Regulation
- Sleep Hygiene
- Behavior treatments
- Anxiety management
- Relaxation/breathing skills

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Measuring and defining attention

- Focused – amount/vigilance
- Sustained – duration
- Divided – simultaneous two or more
- Alternating – switching
- Selected – filtering

No ONE clear way to define OR measure it!

Attention: How do we measure it?

Use standardized, objective measures of function in concert with formal distractions

- Test patient without distractions, record score
- Test patient with distractions, compare score

“Functional attention cost” is the difference
Clinical recommendations

- Have a clinical hypothesis that you wish to test with the patient
- Measure single tasks and dual tasks
  - Determine dual task cost and overall tolerance
- Select tasks that target areas of interest for your patient
- Be sure that single tasks have clear objective measures
- Use more than one combination of tasks

Screening DT tolerance

Tenets of screening:
1. Overlapping of modalities will happen
2. Testing is not intended to be task-specific or functional
3. Test EACH primary and distracter alone
4. To cue, or not to cue…? You must decide…
### Categorizing Interventions

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<th>Cognitive</th>
<th>Motor</th>
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<td>Serial subtraction</td>
<td>Dialing a phone</td>
</tr>
<tr>
<td>- backwards</td>
<td>Memory tasks</td>
<td>Throwing a ball</td>
</tr>
<tr>
<td>- obstacles</td>
<td>Play formations</td>
<td>Pouring water</td>
</tr>
<tr>
<td>Balance - static</td>
<td>Autobiographical info</td>
<td>Pulling items out of a purse</td>
</tr>
<tr>
<td>- dynamic</td>
<td>Information processing task</td>
<td>Button a shirt</td>
</tr>
<tr>
<td>Sports- specific exercises</td>
<td>Read a magazine</td>
<td>Turn pages of a magazine</td>
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### Interventions

Tenets of intervention:

1. Overlapping of modalities will happen
2. Intervention MUST be task-specific/functional
3. Interventions MUST consider patient preference
4. Underestimate patient expectations in DT
5. Either vary or choose NOT to cue prioritization
Interventions

Primary tasks should:

- Be safe to perform with the available assistance: PT, BWS, harness/tracking, etc.
- Be improving in performance through practice
- Have potential to improve

Intervention progression

Functional demands of the person’s environment
Home, work, avocation, sport

Psychological response to error/need for success

Multi-task considerations:
Secondary motor control needs (UE)
Higher-level motor control (gait deviations)
A balance of allowing the patient to struggle enough during safe practice that the nervous system sees a need to make a change. This takes into consideration patient awareness, personality and their current levels of physical abilities.

Goldilocks principle

- “Just right”
- Risks of under dosing
  - Wasted health care dollars
  - Loss of Physician/patient trust
  - Failure to achieve maximum potential

- Risks of overdosing
  - Pain cycle/dizziness/vertigo/possible falls
  - Fear of returning/cancellations
Reminders

Dual task:
- 2 simultaneous tasks
- Can each can be performed and measured alone?
- Do they have separate goals?

Complex single tasks require processing
- can be more than some dual tasks
- depends on novelty & complexity of each task
- Influenced by capability of systems / modalities

GOAL

- Focus on adding more demands to enable the learner to make the primary task (functional mobility, ADLs, sports, etc.) more automatic
LM - dizziness

- B fistula with surgery May 2016
- Presented to PT Aug 2016 with significant dizziness & dystonia
  - Unable to drive or ride as passenger
  - Required min A to ambulate 281’ (2 min) – severe ataxia
  - DHI 78/100 - severe
  - Constant head tremor
- Progress eval (2 months after starting PT)
  - Single TUG – 9.00 sec
  - TUG cognitive – 11.06 sec
  - TUG manual – 15.24 sec

LM case study

- Progress eval (6 weeks later)
  - Single TUG – 9.00 sec → 7.35 sec
  - TUG cognitive – 11.06 sec → 7.68 sec
  - TUG manual – 15.24 sec → 10.68 sec
- 2 min walk – 281’ w/ mina → 493’ no AD
- DHI – 78/100 (severe) → 28/100 (mild)
- Now able to drive, ride as passenger w/out sx’s
- Has returned to work
Videos #1-4

LM case study

- Progress eval (6 weeks later)
  - Single TUG – 9.00 sec → 7.35 sec
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Conclusion

- We must be willing to connect to individuals with post-concussion syndrome…look at the whole person
- We must be comfortable delving into the psychological domain, and find ways to motivate them
- Dual-task training allows for increased automaticity of primary tasks…and increased healing
References


• Young GR, Tsao JW. Rate of Persistent Postconcussive Symptoms. JAMA. 2017 Apr 4;317(13):1375.