Concussion Rehabilitation: Returning to Work

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What is a Concussion ?

- Complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces secondary to direct or indirect forces to the head.
- Acceleration/Deceleration forces cause temporary deformation of axon (axonal stretching)
- Neurometabolic and Physiologic changes at cellular level without visible abnormalities (normal CT/MRI)

Giza 2001

Symptoms of a Concussion

Thinking/Remembering	Physical	Emotional/Mood	Sleep
Difficulty thinking clearly	Headache	Irritability	Sleeping more than usual
Feeling slowed down	Fuzzy or Blurry Vision	Sadness	Sleeping less than usual
Difficulty concentrating	Nausea or Vomiting (early on)	More Emotional	Trouble falling asleep
Difficulty remembering new information	Dizziness	Nervousness or Anxiety	
	Sensitivity to noise or light		
	Balance Problems		
	Feeling Tired		

CDC Traumatic Brain Injury & Concussion

Concussion (MTBI)

- Traumatic brain injury (TBI) is a leasing cause of worldwide disability, with one estimate showing a loss of 56 billion dollars in economic productivity. “

McNamee et al 2009

- “Approximately 80-85% of patients with concussion will recover to their neurological baseline within 1-2 weeks. For the remaining 15-20% with persistent symptoms guidelines for management have NOT been established.

Brain Injury 2015

U.S Bureau of Labor Statistics -2016

- Natural Resources, Constructions & Maintenance Occupations (NRCM) consist of 11.3 million wage and salary workers in the U.S. The largest group (Management, Business, Science & Arts) consists of 40.3 million workers.
- The NRCM group had one of the highest rates of absences due to work-related injuries and illnesses.
  - The number of such incidents per 10,000 full-time workers was 191.6 in NRCM compared with 107.1 for all occupations.
- Median number of days away from work in NRCM was 10 days compared with 9 days for all workers.

U.S Bureau of Labor Statistics -2016

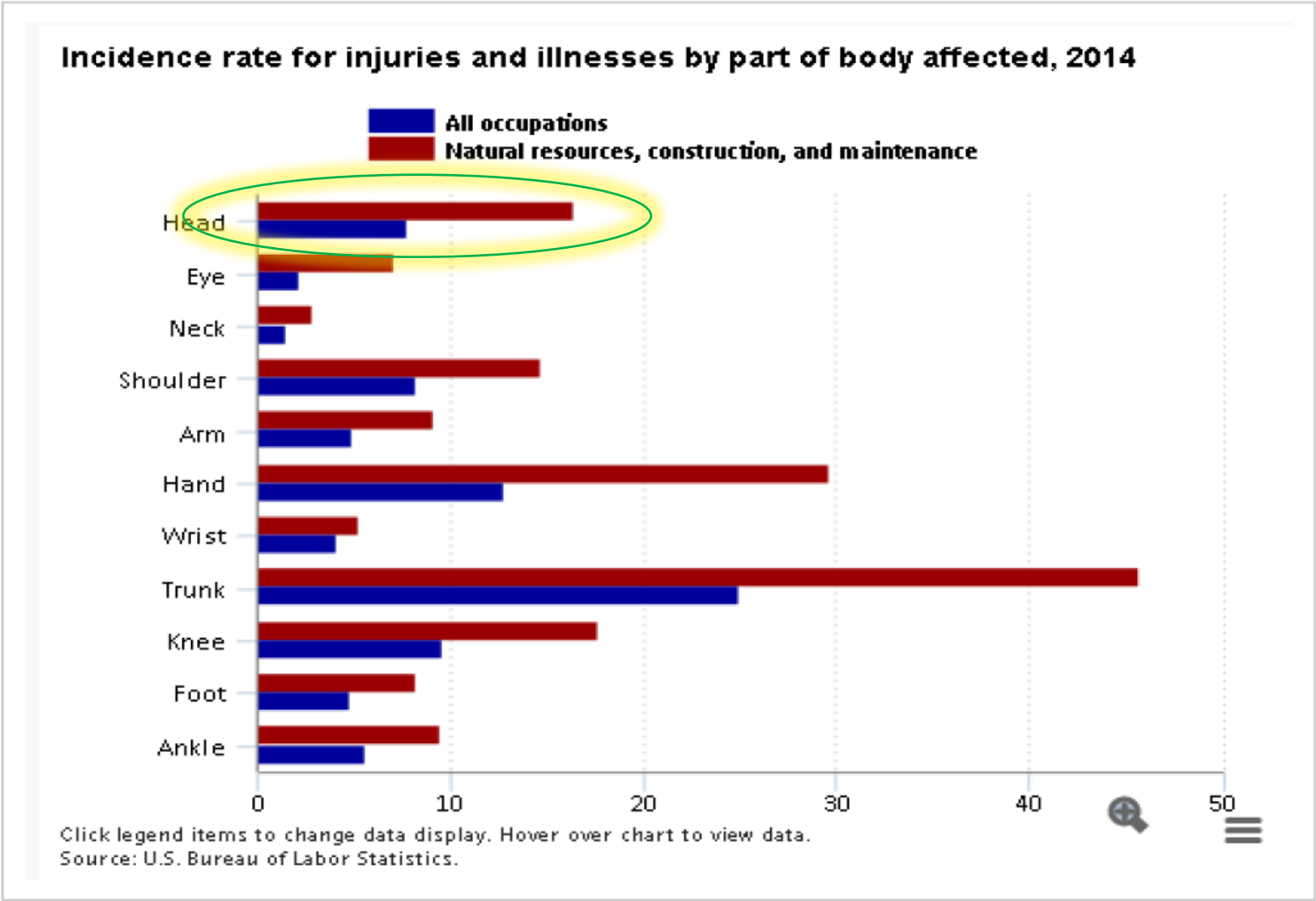
- From March 2004 to March 2015 workers compensation costs as a share of total compensation costs were much higher for natural resources, construction and maintenance that for all occupations.
- In March 2015, employers spent an average of $1.02 per hour for worker's compensation in the NRCM group compared with $0.45 for all occupations.

U.S Bureau of Labor Statistics -2016

- In terms of the body part affected by a workplace injury or illness, the NRCM occupations for trunk, hand and head were nearly twice the comparable rates for all workers.

Body Part	NRCM Incident rates	All Other Group Incident rates
Trunk	45.7	24.9
Hand	29.6	12.7
Head	16.4	7.8

U.S Bureau of Labor Statistics-2016



Strict Rest

- The basis for recommending physical and cognitive rest is it may ease discomfort during acute recovery period and may promote recovery by minimizing brain energy demands following a concussion

However…

- There is currently insufficient evidence that prescribing complete rest achieves these objectives.
    - Br J Sports Med 2017

Strict Rest After Acute Concussion

- Thomas et al. investigated the effectiveness of recommending 5 days of strict rest compared with the usual care of 24 to 48 hours of rest.
- Usual Care (Control) Group: Rest for 1 or 2 days and then return to school and a stepwise return to physical activity only after the patient's symptoms have resolved.
- Strict Rest (Intervention) Group: Maintain 5 days of strict rest at home (no school, work or physical activity) followed by a stepwise return to activity.

Strict Rest After Acute Concussion

- Found that individuals that were randomized to 5 days of strict rest from cognitive and physical activity experienced symptoms longer than the usual care group.
- The strict rest group reported greater total PCSS scores over the course of the 10-day follow-up and a higher total number of post-concussive symptoms.
- No significant difference was found between groups in computer-based neurocognitive tests and balance scores at 3 or 10 days.

Symptoms of Post Concussion Syndrome (PCS)

- Headache*
- Dizziness*
- Blurred Vision*
- Irritability
- Poor Sleep
- Depression
- Feeling frustrated or impatient, panic attack.
- Impaired attention, memory, and/or executive functions.

Savola et al 2003

Persistent Symptoms

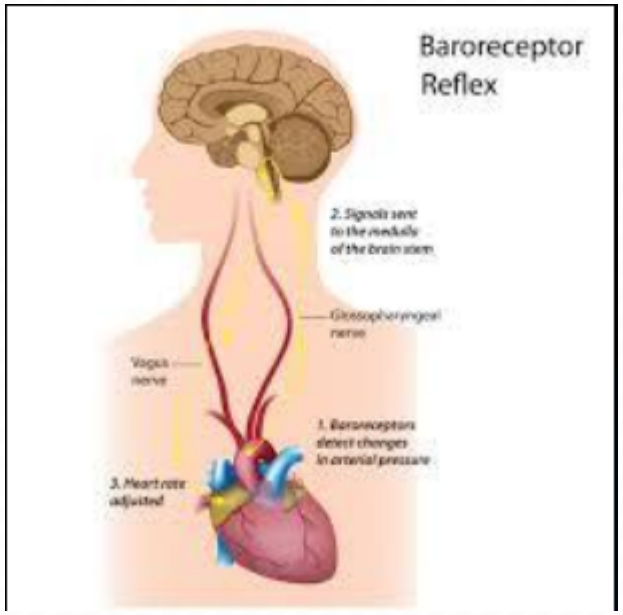
- After a concussion an individual can be symptomatic due to dysfunction in different systems including…

1. The Autonomic Nervous System
2. The Vestibular System
3. The Cervical Spine

- Any or all of these structures may have been effected at the time of the concussive event and are independently sufficient to manifest as symptoms.

Altered ANS Function

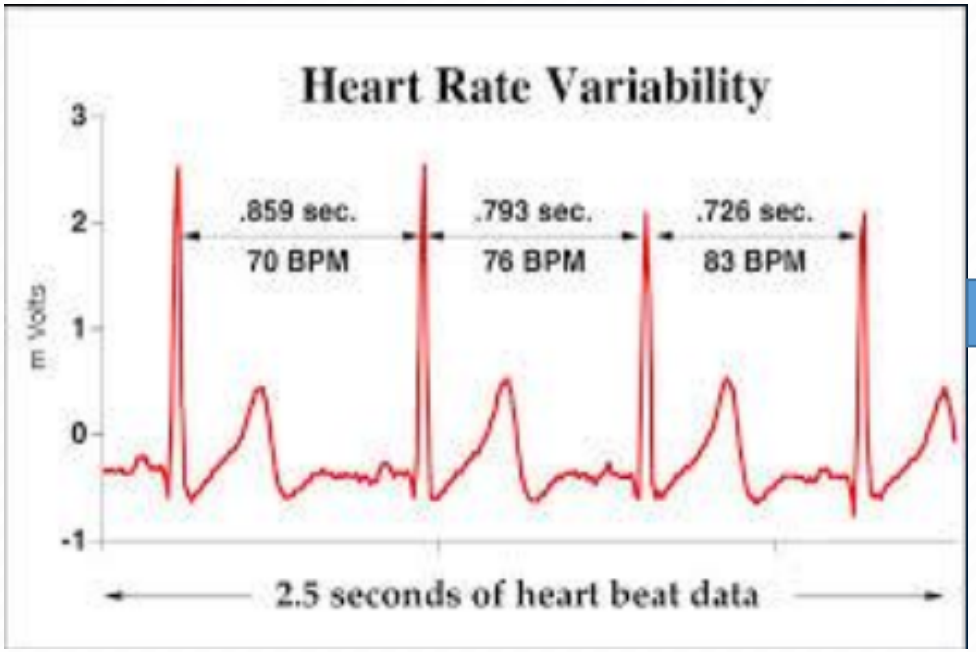
- Hilz et al demonstrated orthostatic intolerance in concussed subjects when moving from supine to standing; indicating inability to switch appropriately from the parasympathetic to the sympathetic branch of the ANS at the right time.



Reduced ability to adjust to postural changes. (Orthostasis, especially in children)

Autonomic Nervous System

- It has been demonstrated that concussed individuals have altered heart rate variability during exercise, which is a reflection of altered balance of the sympathetic and parasympathetic input from the ANS to the heart.



Control of CBF and Cerebrovascular Reactivity

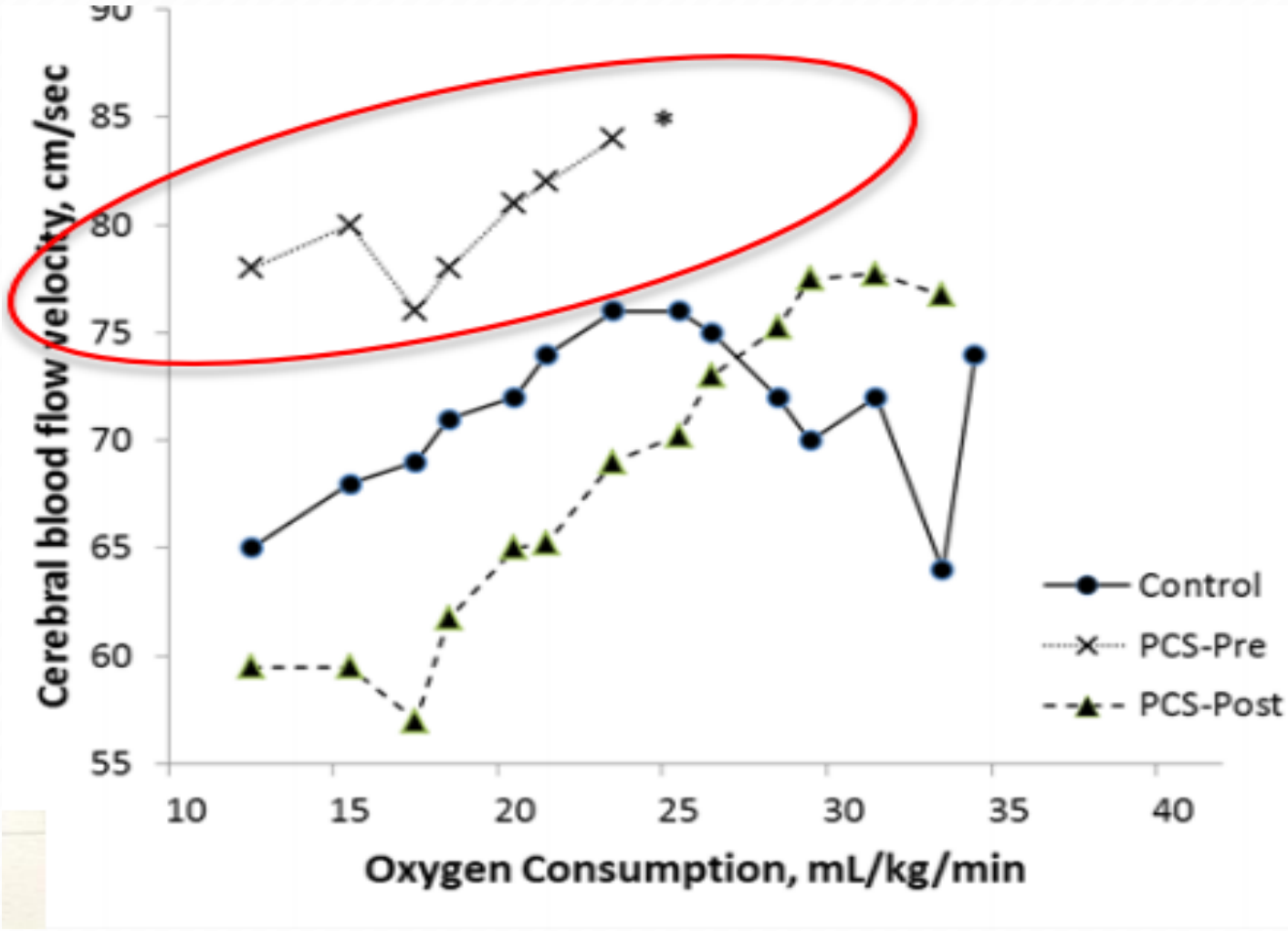
Autonomic Nervous System

- Studies have demonstrated reduced resting CBF for up to a month after concussion.

- Cerebral Blood Flow (CBF) in concussed individuals has been shown to increase out of proportion to exercise intensity compared with non-concussed subjects exercising at the same intensities.

- The elevated CBF is associated with the development of symptoms of headache and dizziness.

CBF during Exercise in Females



Clausen et al 2015

Assessment of the ANS

- The Buffalo Concussion Treadmill Test (BCTT) is the only functional test thus far shown to safely and reliably reveal physiological dysfunction in concussion, differentiate concussion from other diagnoses and quantify the clinical severity and exercise capacity of concussed patients.
  - Physical Medicine and Rehabilitation Journal 2015

Buffalo Concussion Treadmill Test (BCTT)

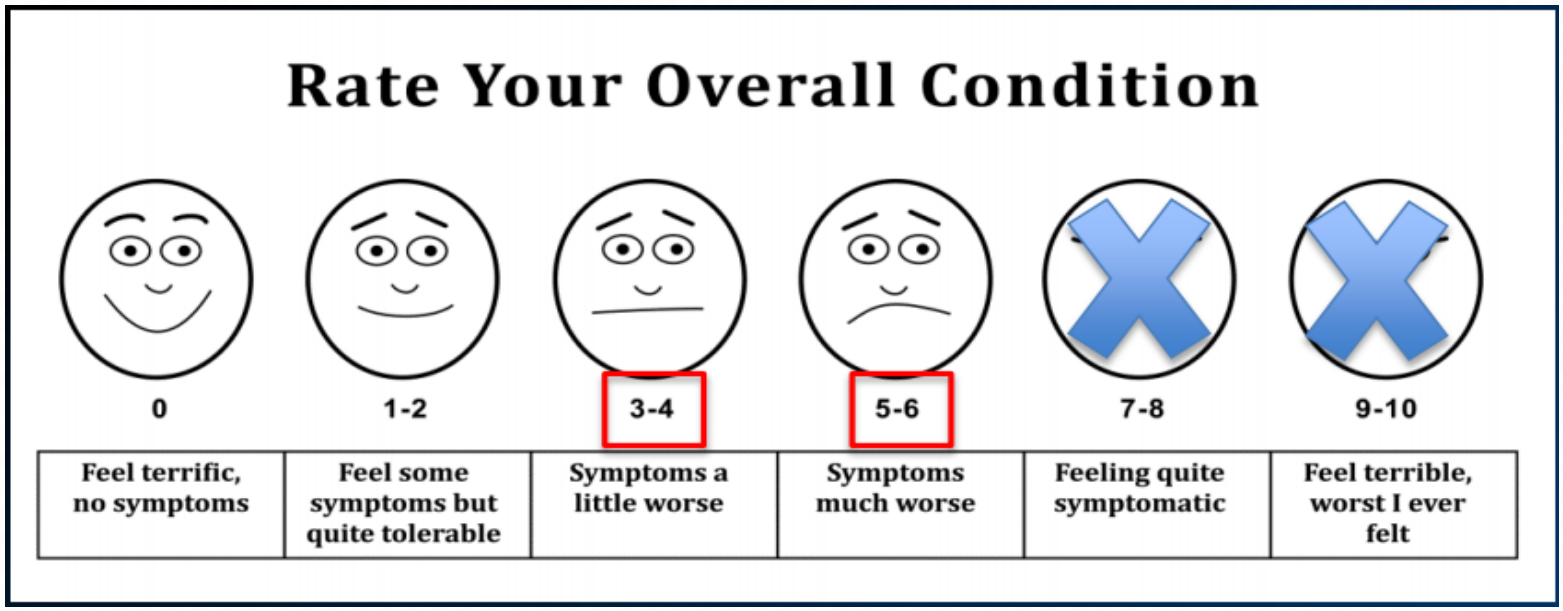
- 15-20 min test of increasing incline 1% per min stopped by either participant reaches max HR or RPE of 19 (exhaustion) or symptoms increased greater than 3 points on the Likert scale (symptom exacerbation).

- Heart Rate, blood pressure, symptoms, and perceived exertion are recorded every 2 minutes until either symptom exacerbation or exhaustion.

- Safe & reliable for evaluation of concussion in workers/athletes with ongoing symptoms
  - J. Head Trauma Rehabil., May 2015

BCTT Stopping Criteria

- Threshold = > 3 points from baseline
- Increased in headaches or dizziness by 3 points or a new symptom appears (1 point for each)



Subsymptom Threshold Exercise Protocol

- Athletes perform aerobic exercise for the same duration achieved during the BCTT, at 80% intensity of the maximum treadmill test (the subsymptom threshold heart rate), once per day for 5 to 6 days per week using a heart rate monitor.

Treatment for ANS Dysfunction

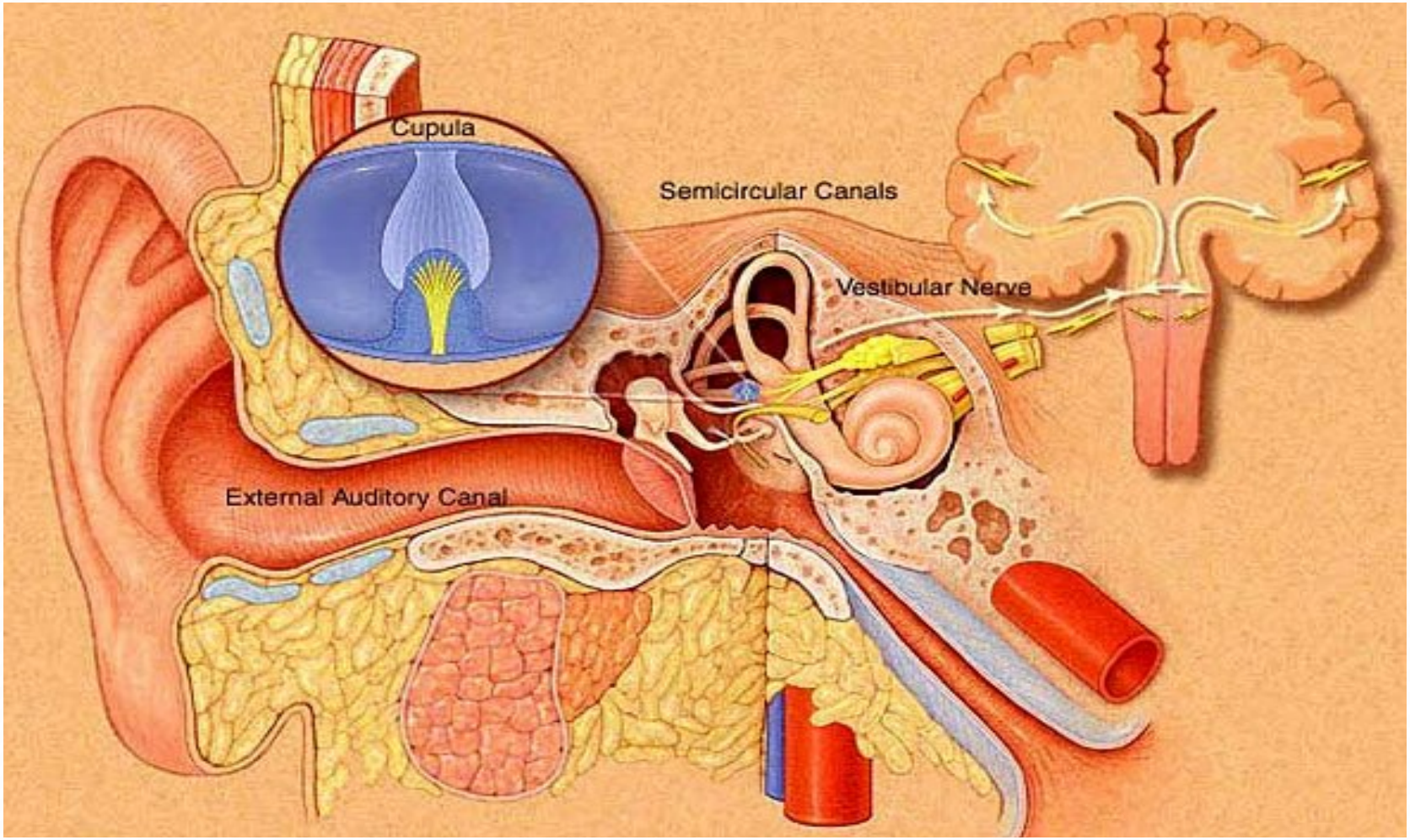
- "Controlled Subsymptom Threshold Training has been shown to restore normal cerebral blood flow regulation in patients with concussions and improve symptoms.

- Progressive stepwise aerobic training may improve CA by conditioning the brain to gradually adapt to repetitive mild elevations of systolic BP."

- "The data suggests that return to normal control of exercise CBF and of exercise tolerance could be objective physiological markers of recovery from concussion, which has implications for establishing prognosis and preventing premature return to sport, activity, or military duty."

  - J. Head Trauma Rehabil., May 2015

The Vestibular & Oculomotor System



The Vestibular System

- This complex system is comprised of highly specialized neural networks that regulate gait, maintain balance and postural control, as well as co-ordinate eye movements.

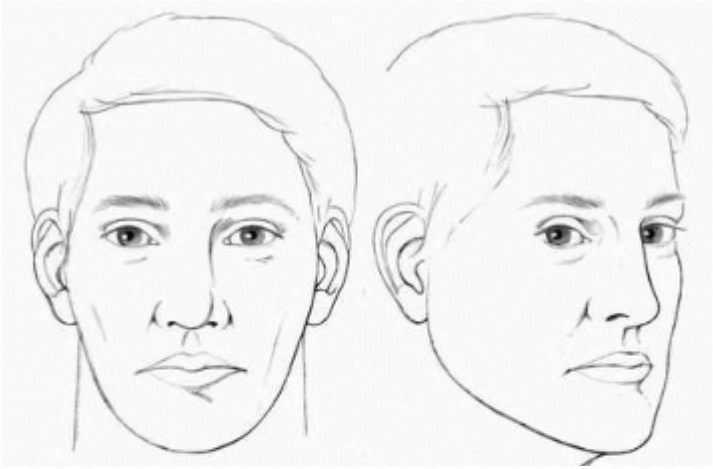
- It consists of special sense organs (the retina, semi-circular canals and otolithic organs and joint mechanoreceptors) that share rich projections to the spinal cord, ANS, brainstem nuclei, cerebellum, thalamus, basal ganglia and cerebral cortex.

  - Brain Injury 2015

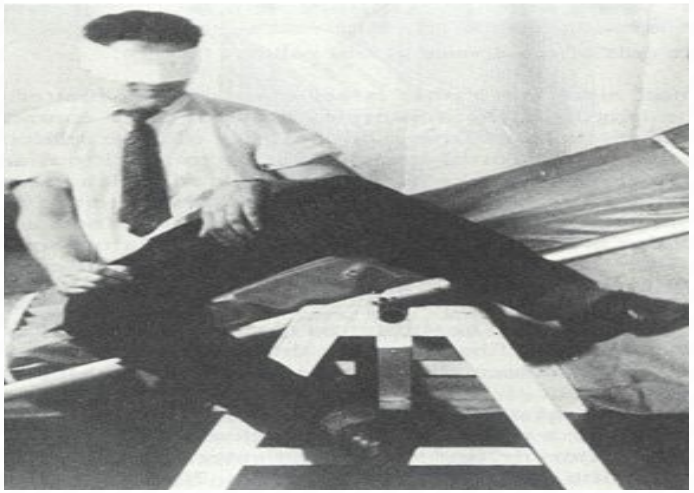
The Vestibulo-Ocular System

- Vestibulo-ocular reflex (VOR): Regulates gaze stabilization during head acceleration
- Vestibulo-spinal reflex (VSR): Co-ordinates head, neck and trunk positioning during dynamic body movements.

VOR



VSR



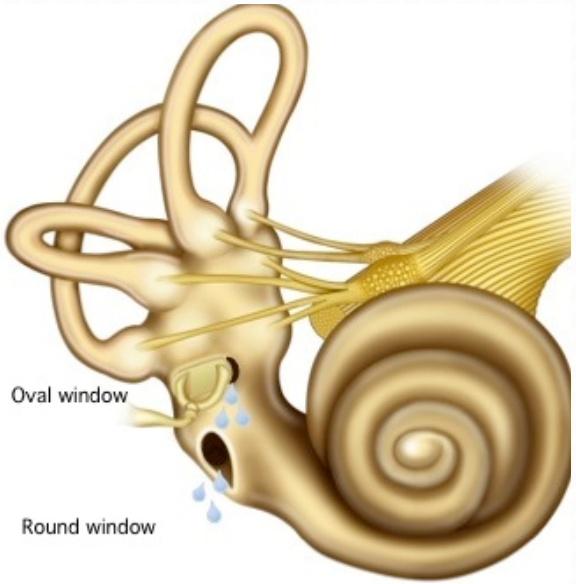
Common Vestibular causes of Dizziness following Concussion

Peripheral Vestibular/Inner Ear:

- Benign Paroxysmal Positional Vertigo (BPPV)
- Perilymphatic Fistula
- Labyrinthine Concussion

Central Vestibular/Brain:

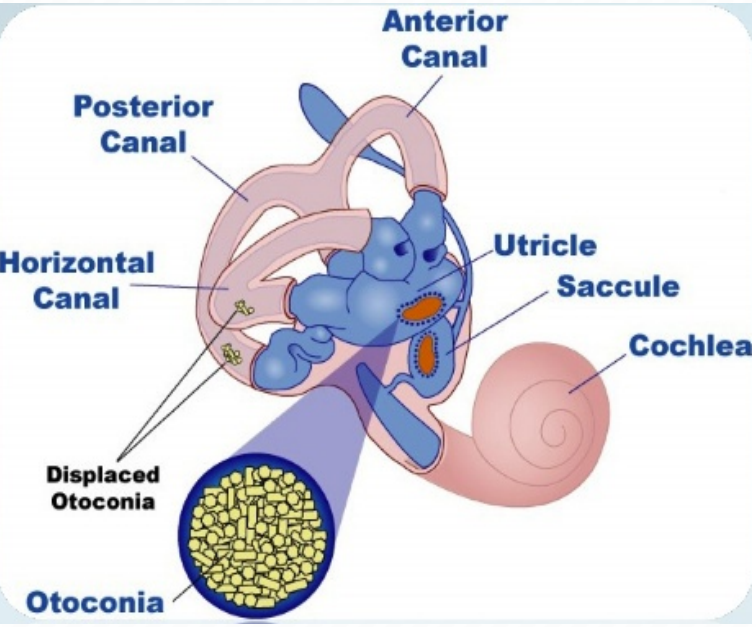
- Post traumatic Migraine
- Brainstem Concussion

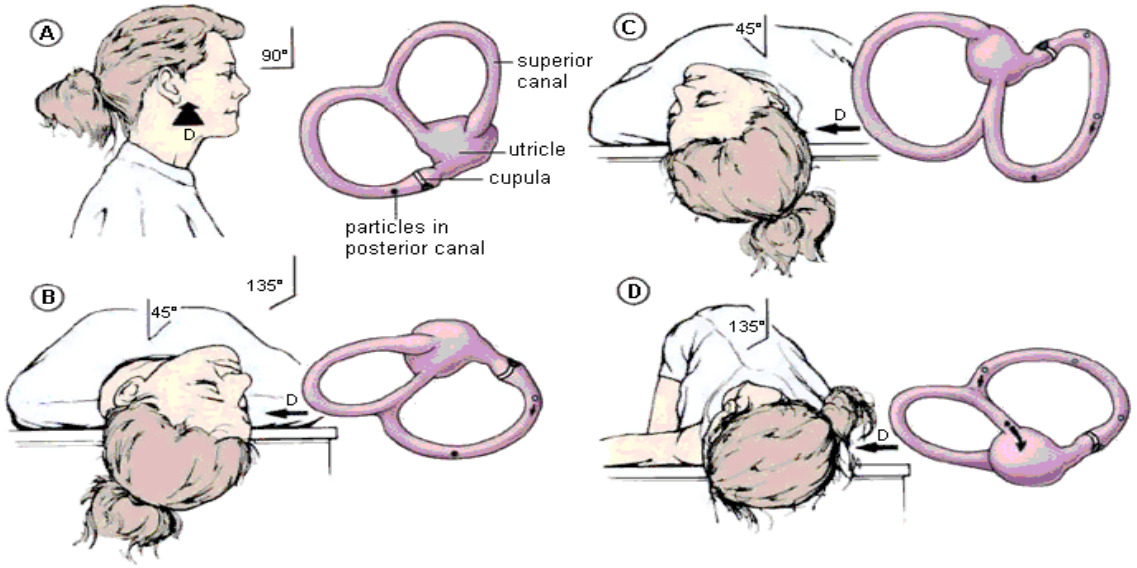


Perilymphatic Fistula

Benign Paroxysmal Positional Vertigo (BPPV)

- Otolithic debris within the Semicircular Canals
- Most common in the Posterior SCC
- More prevalent in moderate/severe TBI
- Treated with Canalith head repositioning maneuvers





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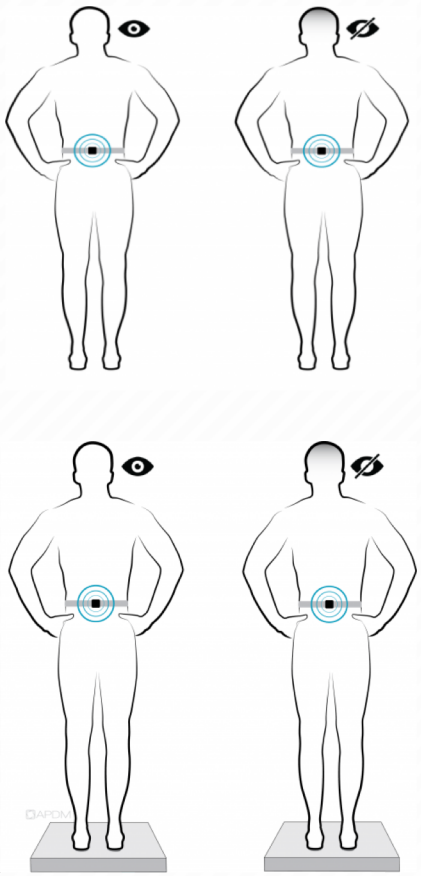
Alsalaheen et al 2010

Vestibulo-Ocular Assessment

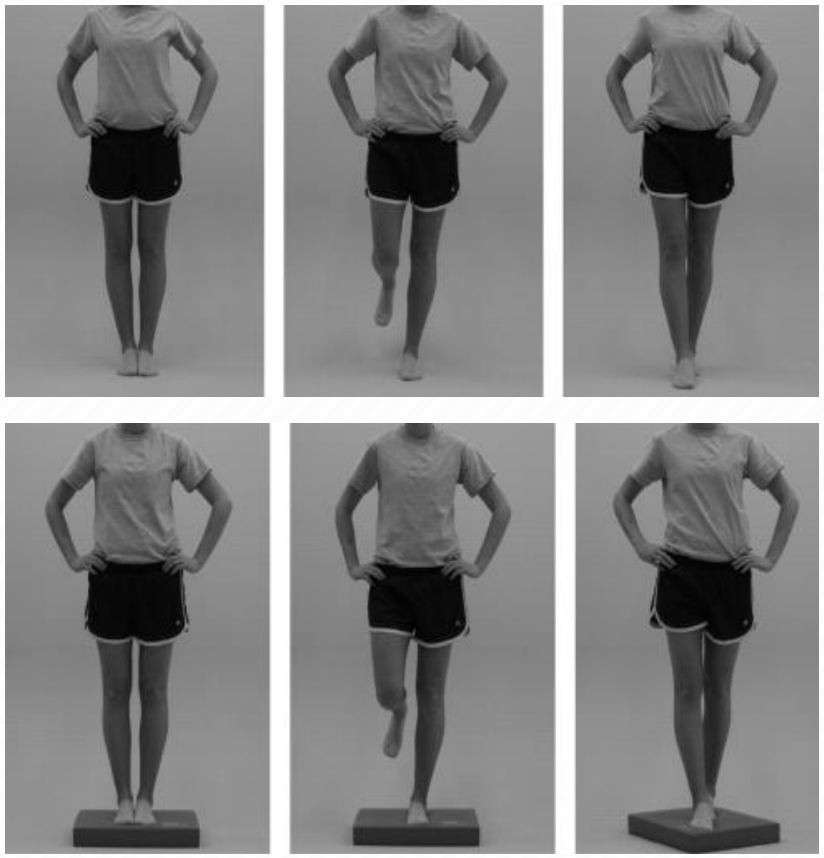
- Difficulty and Reproduction of Symptoms with:
  - Smooth Pursuit
  - Saccades
  - Convergence
  - Vestibulo-Ocular Reflex (VOR)
  - Vestibulo-Ocular Reflex (VOR) Cancellation
- Challenge with Balance Tasks:
  - Clinical Test for Sensory Interaction for Balance (CTSIB)
  - Single leg Stance (Eyes open & Eyes closed)
  - Balance Error Scoring System (BESS)

Balance Testing

- CTSIB



- BESS



Vestibulo-Ocular Treatment

- The underlying goal of vestibular rehabilitation is to recalibrate depth and spatial perception under static and dynamic conditions by re-establishing efficient integrations of the vestibular, visual and somatosensory sub-systems.

  - Brain Injury 2015

VOR Adaptation Treatments

- These exercises are based on the ability of the vestibular system to make long-term changes in the neuronal response to input.

- Two sensory stimuli are required for significant adaptation of the VOR: Vison and Head Motion.

VOR Adaptation Exercises

- Gaze Stabilization Exercises:
  - Goal is for the eyes to stay fixed on a target during a head movement.
  - Creates a small amount of retinal slip.

a) **VOR x 1:** the patient attempts to maintain fixation on a target while moving their head.
b) **VOR x 2:** involves repeated eye and then head movements between two targets
c) **Imagining Fixation:** the patient looks at a target, then closes their eyes and while trying to keep eyes on the remembered target, turns their head.

Habituation Treatment

- These exercises are based on the concept that repeated exposure to a provocative stimulus will result in a reduction in the pathological response to that treatment, which is presumably a central process.
- Based on the Motion Sensitivity Quotient (MSQ)
- The patient performs these movements 2 or 3 times, twice a day.
- Should be performed quickly enough and through sufficient range to produce mild to moderate symptoms.

Motion Sensitivity Quotient Test

Name: _____ Age: _____ Gender: _____ Date: _____

Baseline Symptoms	INTENSITY	DURATION	SCORE
1. Sitting-to-supine			
2. Supine-to-left side			
3. Supine-to-right side			
4. Supine-to-sit			
5. Left Hallpike-Dix test			
6. Return from Hallpike-Dix test			
7. Right Hallpike-Dix test			
8. Return from Hallpike-Dix test			
9. Sitting: nose toward left knee			
10. Return to sitting			
11. Sitting: nose toward right knee			
12. Return to sitting			
13. Sitting: head rotation 5×			
14. Sitting: head flexion and extension 5×			
15. Standing: turn right (180°)			
16. Standing: turn left (180°)			
Intensity: rated from 0 to 5 (0 = no symptoms; 5 = severe symptoms)			
Duration: rated from 0 to 3 (5-10 sec = 1 point, 11-30 sec = 2 points, ≥30 sec = 3 points)			

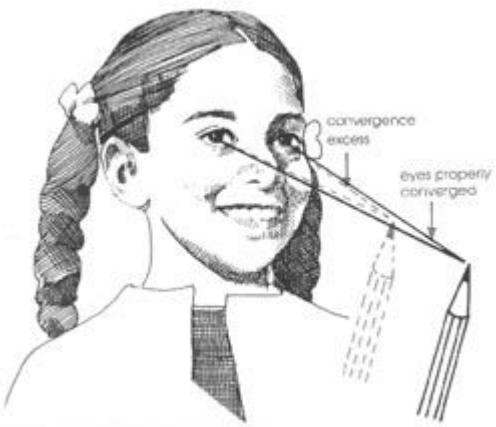
Motion sensitivity quotient: $\frac{\#\text{Provoking positions} \times \text{score} \times 100}{2048} =$ _____ Total

Note: An MSQ score of zero means no symptoms and 100 means severe dizziness in all positions.

Source: Susan B. O'Sullivan, Thomas J. Schmitz, George D. Fulk: Physical Rehabilitation, Sixth Edition
www.FADavisPTCollection.com

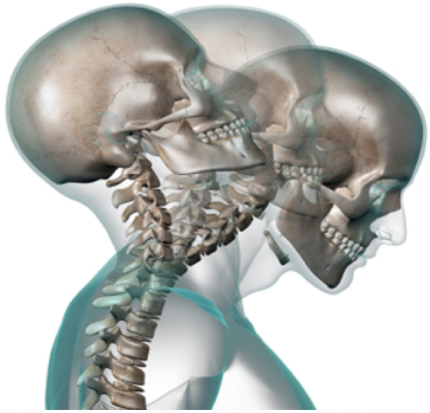
Oculomotor Treatment

- Convergence Exercises:
  - Pencil Push-Ups
  - Brock String
- Smooth Pursuit
- Saccades



The Cervical Spine

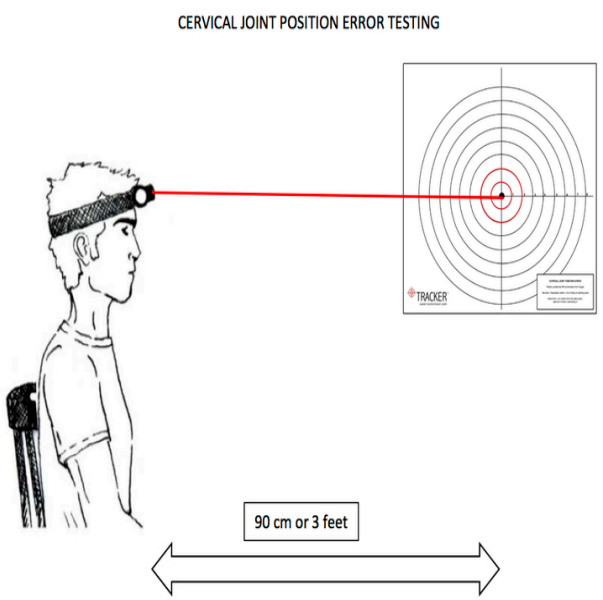
- The cervical spine consists of a high density and complexity of muscles and joint mechanoreceptors that are a rich source of proprioceptive information that convey to multiple levels of the CNS; including the cerebellum, brainstem and spinal cord.
- Three primary categories of mechanisms can be proposed:
    1) Cervical mobility dysfunction
    2) Neuromuscular control
    3) Strengthening.



The International Journal of Sports Physical Therapy 2017

Cervical Spine Assessment

- Reproduction of Symptoms and limitations with:
  - Cervical Joint Position Error Test
  - Cervical Active ROM
  - Cervical Muscular Trigger Points
  - Cranial Cervical Flexion Test
  - Cervical Traction Test
  - Head-Neck Differentiation Test



Cervical Spine Symptoms

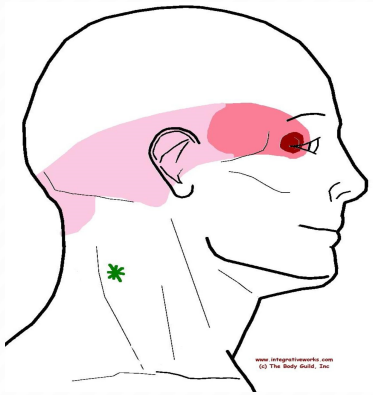
- The predominant complaints of patients with cervicogenic concussion symptoms consist of:
  - Neck Pain
  - Neck Stiffness
  - Head and Neck Fatigue
  - Decreased neck range of motion
  - Headaches

- Individuals may also complain of associated symptoms such as:
  - Dizziness
  - Light-headedness
  - Fogginess
  - Feelings of being “detached” or “out of it”

- Bran Injury 2015

Cervical Mobility Dysfunction

- Afferents from the C2 and C3 dorsal root ganglia terminate on the same second-order dorsal root ganglia as do many nociceptive afferents arising from the trigeminal sensory nucleus.
- This critical convergence provides a mechanism for referred pain from upper cervical structures (from C0 to at least C3) to the upper cranium and forehead, mimicking a headache.



- Phys Sportsmed 2015

Cervical Mobility Treatment

- Manual Therapy has been shown to have positive benefits for treatment of hypomobile segments in the cervical and thoracic spine for individuals following a concussion and whiplash associated disorders.
    - The International Journal of Sports Physical Therapy 2017


SHUTTLE

Neuromuscular Control Dysfunction

- Deep Cervical Flexor muscles are richly innervated with muscle spindles that provide proprioceptive and kinesthetic feedback.
- Altered proprioceptive input in the neck can result in altered perceived head position.
- The rapid acceleration/deceleration of the head that can occur during a concussion can result in trauma to the mechanoreceptors in the cervical spine.
    - The International Journal of Sports Physical Therapy 2017

Neuromuscular Control Treatment

- Utilizing pressure biofeedback to active deep neck flexors (longus capitus and longus colli), has been shown to be helpful for cervicogenic headaches by improving cervical kinesthesia.
- Addressing body mechanics and posture during school, daily activities and work can reduce strain on the spine that can lead to headaches and neck pain.
    - The International Journal of Sports Physical Therapy 2017

Cervical Strength Dysfunction

- Deep Neck Flexor Endurance (DNFE) Test is a way to measure the strength of the neck stabilizers.
  - Mean time for those without neck pain was 39 seconds for men and 29 seconds for women.
  - Hold time durations were significantly different between individuals with and without neck pain.

The International Journal of Sports Physical Therapy 2017

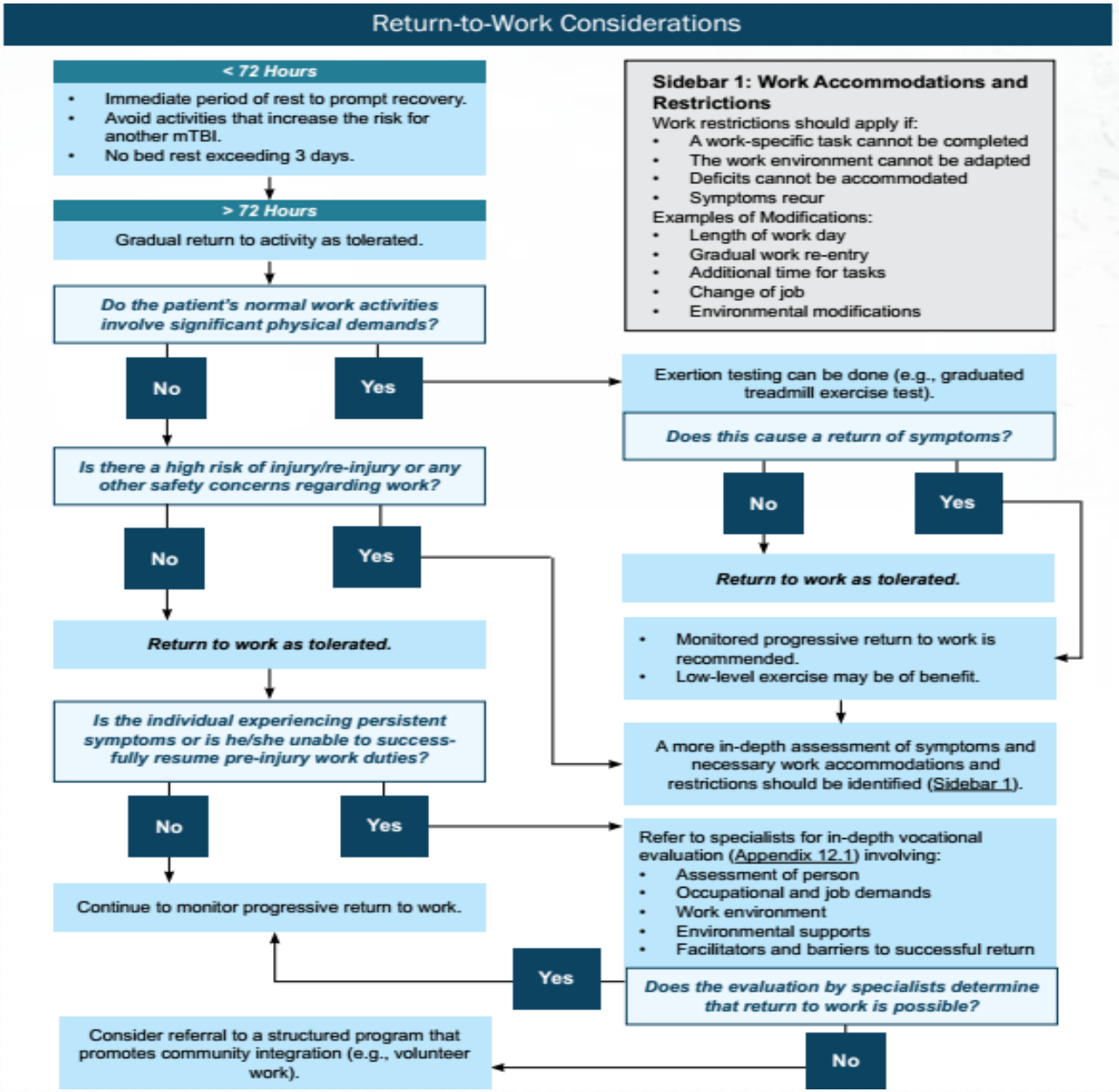
Return to Work Considerations

- Individually based work restrictions should apply if:
  - There is a work-specific task that cannot be safely or competently completed based on symptoms
  - The work/duty environment cannot be adapted to the patient's symptoms-based limitation
  - The deficits cannot be accommodated
  - Symptoms recur

- Examples of Vocational Modifications include:
  - Modification of the length of the work day
  - Gradual work re-entry
    - Starting at 2 days/week & expanding to 3 days/week)
  - Additional time for task completion
  - Change of Job
  - Environmental Modifications (quieter work atmosphere, enhanced level of supervision)

Management of the Post Concussive Employee: Multidisciplinary Team

- Core Medical Team
  - Neuropsychology
  - MD (Concussion Background)
  - Physical Therapy
- Employment Team
  - Nurse Case Manager/Adjuster
  - Employer
  - Manager/Supervisor
  - Co-workers
- When Needed
  - Neuro-Otology
  - Neuro Opthalmology/ Optometry
  - Psychology/Psychiatry
  - Cognitive Therapy



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