

Concussion is Treatable Beginning Treatment the Day After the Mechanism



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I have no financial conflicts with this presentation



IG SKY ATHLETIC TRAINING AND SPORTS MEDICINE CONFERENCE

Outline of Presentation

- Definition of Treatment vs Return to play
- Justification for early treatment
- Risk factors and predictors prolonged recovery
- Rethinking the term concussion
- Profiles/Disorders/Dysfunction/Deficits/ Subtypes to be determined by the evaluation
- Categories for post-concussion follow up evaluation
- Treatment Philosophy and Outline
 - Definition of rest
 - Sleep
 - Exercise
 - Nutrition
 - Profiles/Deficits treatment
 - Cervicogenic
 - Psychological
 - Vestibular
 - Oculomotor
 - Cognitive Fatigue
 - Migraine
- Sport Reaction Time Training
- Criteria for return to play
- Informed consent



Practical Implementation of Concussion Treatment

Definitions

Treatment: Any intervention that occurs between injury mechanism and clearance to return to sport. May also include intervention done after athlete returns to sport.

Return to Play: Progression from medical clearance to return to sport and full unrestricted play

Initial Evaluation

On field- "Go or No Go"

Serial follow up evaluations

Initial take home education and instructions for family and patient

Referral for further assessment if more than a "concussion"



http://www.cdc.gov/concussion/pdf/TBI_Patient_Instructions-a.pdf

Early Treatment

Begin active treatment while still symptomatic

Misconceptions

1. Once an athlete is cleared to return they are 100% recovered
2. There is nothing that can be done to help with recovery or improve function



Justification for early treatment



In pediatric population vestibulo-ocular dysfunction (VOD) is a significant risk factor for developing Post Concussion Syndrome

VOD was found in 28% of acute sports related concussions in pediatric population

VOD was found in 62% of post concussion syndrome patients in pediatric population

Can early assessment, recognition and treatment prevent some of these PCS cases? YES

- Ellis M.. Et al, **Vestibulo-ocular dysfunction in pediatric sports-related Concussion.** *J Neurosurg Pediatr* 2015

Justification for early treatment

- Cerebellum will accommodate for abnormalities
- Vestibular System accommodations can become ingrained if not corrected early

• DON'T IGNORE FATIGUE



Ellis M.. Et al, **Vestibulo-ocular dysfunction in pediatric sports-related Concussion.** *J Neurosurg Pediatr* 2015

Justification for early treatment Performance

- MLB Players had lower batting average, slugging percentage and on base percentage in the 2 weeks after return from concussion vs players on bereavement/paternity leave players. (2)
- Study of NFL players show no difference in player performance after concussion whether return to play within one week or longer. (3)
- Schmidt et. al 2017 UGA- Less vehicle control even after symptoms resolve (4)

(2) Wasserman EB, et al. **Concussions are associated with decreased batting performance among Major League Baseball players.** *Am J Sports Med* 2015
 (3) Kumar NS, **On-field Performance of National Football League Players After Return From Concussion.** *Am J Sports Med* 2014
 (4) Schmidt JD, et al. **Driving after Concussion: Is It Safe to Drive After Symptoms Resolve** *J Neurotrauma* 2017

Justification for early treatment Risk of Injury

- Increase risk of injury after cleared to return to play after concussion.
According to Lynall et al. "*Up to 180 days after concussion, the group with concussion was 2.02 (95% CI, 1.08-3.78; P = 0.02) times more likely to have experienced an acute lower extremity musculoskeletal injury after concussion than before concussion.*" (1)
- Study former NFL players greater number of concussion greater number of relative risk for lower extremity musculoskeletal injuries (4)
- College athletes with concussion higher risk of non-contact LE Strain/sprain. (5)
- Positive association between concussion history and lower extremity injuries (odds ratios, 1.6-2.9 elevated risk) among student-athletes at the conclusion of their intercollegiate athletic careers. (6)

(1) Lynall RC, Mauntel TC, Padua DA, & Mihalik JP. (2015). **Acute lower extremity injury rates increase following concussion in college athletes.** *Med Sci Sports Exerc.*
 (4) Pietrosimone et al. *Med Sci Sports Exerc* 2015
 (5) Brooks et al. 2016 *American Journal of Sports Medicine*
 (6) Gilbert et al. 2016 *Sports Health. Association Between Concussion and Lower Extremity injuries in Intercollegiate Athletes.*

Hypothesis for increase in risk

Increase risk of lower extremity injury after return to sports post concussion has been hypothesized as change in proprioception and lower extremity muscle tone from altered oculomotor system



Justification for early treatment Risk of Injury

Lower Extremity Stiffness Changes after Concussion in Collegiate Football Players

- Lower extremity stiffness is altered after concussion, which could contribute to an increased risk of lower extremity injury. These data provide further evidence of altered neuromuscular function after concussion
- Concussion group showed an increase in hip stiffness, a decrease in knee and leg stiffness but no change in ankle stiffness from pre- to postseason
- A motion capture system recorded subjects jumping on one limb from a 25.4-cm step onto a force plate.

DuBose et al. *Medicine & Science in Sports & Exercise*: Jan 2017

Prolonged Effects of Concussion?

More research and testing is showing that there may be persistent alteration in brain function after concussion.

Lancaster, Olson, McCrea et al 2016. White matter changes at 6 months

Purdue Neurotrauma Group. Changes from contact without symptoms

Current tools are not be sensitive enough to detect

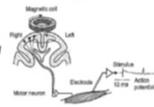


Prolonged Effects of Concussion

❑ Persistent alterations in brain function cannot be detected by standard neuropsychological tests

- Transcranial Magnetic Stimulation + Electromyography
 - Chronic subclinical motor system dysfunction
 - Intracortical inhibition of neural transmission (GABA_B)

De Beaumont et al. 2012, *Cereb Cortex*
 De Beaumont et al. 2012, *Neurosurg Focus*
 Thériault et al. 2011, *J Clin Exp Neuropsychol*
 Tremblay et al. 2011, *J Neurotrauma*
 De Beaumont et al. 2007, *Neurosurg*
 McDonnell et al. 2006, *Exp Brain Res*



Slide from Gary Wilkerson

Re-thinking the term concussion

- Concussion induced traumatic headache
- Concussion induced cognitive deficit
- Concussion induced oculomotor disorder
- Concussion exacerbated psychological condition
- Concussion induced cognitive fatigue
- Concussion induced vestibular disorder
- Concussion induced cervical sprain

More accurate- Concussion induced traumatic headache, vestibular dysfunction and anxiety exacerbation



Evaluation to determine clinical subtypes

Review of mechanism of injury; specifically location, force and direction of trauma (Bloom & Blount, 2015; Collins et al., 2014; Ellis et al., 2014; Giza et al., 2013; Harmon et al., 2013; McCrory et al., 2013)

Relevant past medical history including age, gender, prior concussion history, and comorbid 'concussion risk factors' (Elbin et al., 2014; Kontos et al., 2012; Lau et al., 2011; Meehan et al., 2014)

Symptom checklist (Bloom & Blount, 2015; Collins et al., 2014; Ellis et al., 2014; Giza et al., 2013; Harmon et al., 2013; McCrory et al., 2013)

Neurocognitive screening or evaluation (Bleiberg et al., 2004; Guskiewicz et al., 2001; Iverson et al., 2003; Iverson et al., 2004; Iverson et al., 2006; Lau et al., 2011; Lau et al., 2010; Lau et al., 2010; VanKampen et al., 2006)

Balance assessment (Guskiewicz et al., 2001; Guskiewicz et al., 2003; Register-Mihalik et al., 2008; Sosnof et al., 2011)

Vestibular screening or examination (Alsalaheen et al., 2010; Ellis et al., 2014; Mucha et al., 2014)

Assessment or screening of ocular motor function (Ellis et al., 2014; Mucha et al., 2014; Pearce et al., 2015; Polltaaki & Biberdorf, 2014)

Neurological exam (Bloom & Blount, 2015; Collins et al., 2014; Ellis et al., 2014; Giza et al., 2013; Harmon et al., 2013; McCrory et al., 2013)

Examination of the cervical spine (Bloom & Blount, 2015; Collins et al., 2014; Schneider et al., 2014)

Consideration of neuroimaging if indicated (DiFiori & Giza, 2010; Esteban et al., 2012; Yuh et al., 2014)

PMH of risk factors

Slide from presentation by Michael Collins PhD

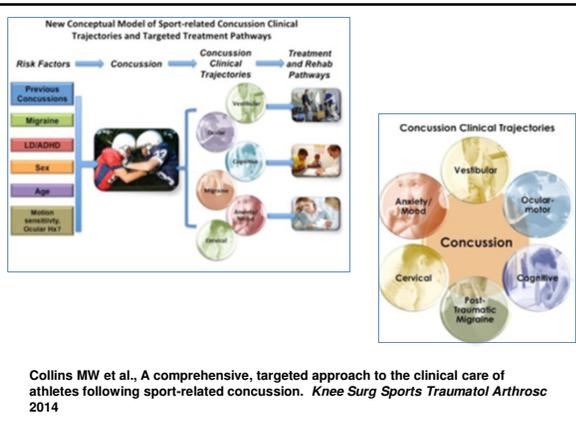
Profiles/Disorders/Dysfunction/Deficit/ Subtypes to be determined by the evaluation

- 1) Vestibular
- 2) Ocular-motor
- 3) Cognitive/cognitive fatigue
- 4) Post-traumatic migraine/headaches
- 5) Psychological Anxiety/Mood
- 6) Cervicogenic?



"Dewey! Grandpa's stuck again. Give him a couple of whacks upside the head."

These subtypes are a work in progress and will change by what we continue to learn.



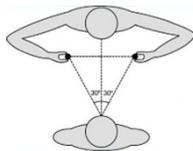
Smooth Pursuit

- Ability to track a slowly moving target
- May become “jerky” in concussion



Saccades

- Ability to quickly move the eyes from one target to another
- After 3-4 attempts, should be able to precisely reach two stationary targets
- May see “undershoot” or “overshoot” in concussion



Vestibulo-Ocular Reflex (VOR)

- Counter-movement of the eyes to maintain focus on a visual target during a fast head turn
- May be jerky or unable to maintain fixation in concussion



VOR Suppression (Visual Motion Sensitivity)

- Ability to suppress counter-movement of the eyes during fast head turning, maintaining focus on a moving target
- May be jerky or unable to maintain fixation in concussion



VOMS Considerations

Advantages

- Easy to administer
- High correlation with symptoms
- High sensitivity: (+) identify concussion
- Assists in targeted treatment plan



Possible Limitations

- Unknown inter-tester reliability
- Relying on symptoms can result in recall bias
- Convergence only measured test
- No correlation to BESS
 - May not be sensitive to dynamic vestibular function

Vestibular/Ocular-Motor Screening (VOMS)



NAME _____ Patient Label
 ID# _____
 DATE _____ TIME _____

VOMS SCORING SHEET

Symptoms on a 0-10 point scale

Subtest	Type	Net Score	Headache	Double Vision	Nausea	Photopsia	Convergence
Baseline							
Symptoms							
Smooth Pursuit							
Saccades (Horizontal)							
Saccades (Vertical)							
Convergence (Near Point)							Score#1: ___/10 Score#2: ___/10 Score#3: ___/10
VOR Horizontal							
VOR Vertical							
Visual Motion Sensitivity							

Physician AT Signature _____ Documented in EMR

Mucha et al. A Brief Vestibular/Ocular Motor Screening (VOMS) Assessment to Evaluate Concussions: Preliminary Findings. American Journal of Sports Medicine 2014

Advanced Assessment of Dizziness

TABLE 2. Modified Dizziness Handicap Inventory*

During the Past Week Have You Experienced		None	Mild	Moderate	Severe			
1	Dizziness? (if no, mark 0 for all other questions)	0	1	2	3	4	5	6
2	Dizziness when looking up?	0	1	2	3	4	5	6
3	Dizziness when walking down aisles, hallways, etc?	0	1	2	3	4	5	6
4	Dizziness when turning over, getting out of bed, or when lying down?	0	1	2	3	4	5	6
5	Dizziness when reading?	0	1	2	3	4	5	6
6	Dizziness during quick head movements?	0	1	2	3	4	5	6
7	Dizziness when bending over?	0	1	2	3	4	5	6
8	Dizziness in open spaces?	0	1	2	3	4	5	6

*Participants responded verbally to each question and answers were recorded by the clinician. This Likert scale is identical to that used in the Post-Concussion Symptom Scale.

NEUROSURGERY VOLUME 0 | NUMBER 0 | MONTH 2015 | 8

Henry LC, et al. Examining Recovery Trajectories After Sport-Related Concussion With a Multimodal Clinical Assessment Approach. Neurosurgery. 2015

Oculomotor Assessment

Evaluation

- VOMS- Convergence, Pursuit, Saccades
- King-Devick
- ImFACT- Visual Memory, reaction time (Collins et al 2014)

Questions (Collins)

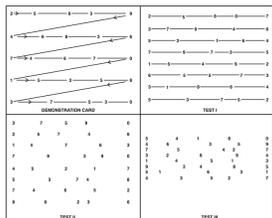
- Do you feel a frontal pressure in your head/behind your eyes when reading doing computer work?
- Do you have blurred or double vision while reading or difficulty reading
- Are you having more significant difficulty in math/science?
- Are you fatigued after a lot of schoolwork?

Oculomotor Disorder

- Symptoms (Ciuffreda, 2011)
 - Difficulty reading, dizziness, headaches, ocular pain, poor visual based concentration
 - End of day fatigue
- Family History of lazy eye, nystagmus
- May manifest into poor academic/work performance, motion sensitivity/car sickness (Collins, 2014)
- Convergence insufficiency was common (~42%) in athletes evaluated within 1 month after an SRC. (Pearce et.al 2015)

Oculomotor Screening

- Smooth pursuit and ocular ROM
- Saccades
- Gaze stability
- Vergence
- Eye alignment



Oculomotor Test

Near Point of Convergence

- Ask the patient to look at a small letter on a stick that looks like a tongue depressor and instructs the patient to keep the letter single as it moves closer and closer to the bridge of the nose.
- Should be able to maintain single vision until the object reaches about 6 cm (2 inches) from the bridge of the nose.



Convergence

- Ability to follow a visual target in towards the nose
- The "near point" is the closest distance to the nose without double vision or one eye deviating outwards
- Normal is less than 6cm



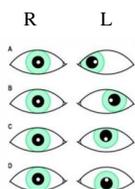
Convergence Insufficiency

- Inability to maintain binocular function (keeping the two eyes working together) while working at a near distance
 - Typically, one eye will turn outward (intermittent exotropia) when focusing on a word or object at near
- Symptoms
 - Diplopia & Headaches when reading
 - Difficulty concentrating on near work (computer, reading, etc.)
 - Written word blurs after prolonged periods of reading or if reading when tired
- Remote near point of convergence
 - Maintain binocular fixation on a fusional target up to at least 5 inches from the tip of the nose

<https://www.slideshare.net/mobile/maclester/near-point-of-convergence>

Eye Alignment and Symmetry

- Ask patient to look at target 6-8 feet away
- Observe eye alignment
- Should be symmetrical at center
- Left-right
- Up-down



Red Flags for More Advanced Evaluation

Oculomotor

- Visual acuity change
- Flashes of light
- Diplopia
- Mal-alignment of eyes
- NPC not resolving quickly

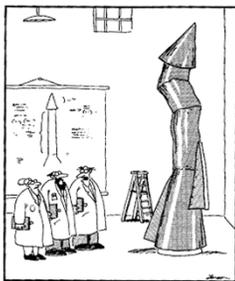
Vestibular

- Hearing changes
- Ringing in ears
- Vertigo-spinning
- Dizziness with strain



Musculo-Skeletal and Gait Assessment

- Gait Assessment
 - Abnormalities could be Oculomotor or Vestibular spinal
- Cervical Assessment



"It's time we face reality, my friend. ... We're not exactly rocket scientists."

Cervicogenic Headache

Cervicogenic headache is a syndrome characterized by chronic hemicranial pain that is referred to the head from either bony structures or soft tissues of the neck. (1)

Biondi, D. **Cervicogenic Headache: A Review of Diagnostic and Treatment Strategies.** *J Am Osteopathic Assoc.* 2005

Checklist

- Unilateral head or face pain without sidebit; the pain may occasionally be bilateral
- Pain localized to the occipital, frontal, temporal or orbital regions
- Moderate to severe pain intensity
- Intermittent attacks of pain lasting hours to days, constant pain or constant pain with superimposed attacks of pain
- Pain is generally deep and nonthrobbing; throbbing may occur when migraine attacks are superimposed
- Head pain is triggered by neck movements, sustained or awkward neck postures, digital pressure to the suboccipital, C2, C3, or C4 regions or over the greater occipital nerve, sneeze, cough or sneeze might also trigger pain
- Restricted active and passive neck range of motion, neck stiffness
- Associated signs and symptoms can be similar to typical migraine accompaniments including:
 - nausea;
 - vomiting;
 - photophobia, phonophobia, and dizziness;
 - others include ipsilateral blurred vision, lacrimation and conjunctival injection or ipsilateral neck, shoulder or arm pain

Neurocognitive/Neuropsychological Assessment

- ImPACT
- C3 Logix
- ANAM
- CogState
- XLNTbrain Sport
- Concussion Vital Signs
- Paper and pencil exams



These are not pass/fail tests. They give you information to guide care and treatment. Neuropsychologists expertise

How Are Concussions Currently Managed?

REST

Physical Rest

Cognitive Rest

“Rest”

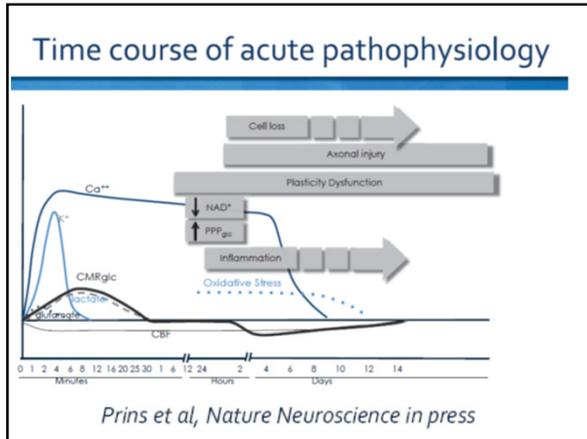
- Initial education post concussion. **Avoiding any exacerbating activities.**
- Teach and allow patient autonomy to control their own activity (physical and cognitive) to manage symptoms
- **NO SECONDARY TRAUMA** *Most important (1,2,3)
 - Second Impact Syndrome- Immature brain
 - **Period of vulnerability**
 - Decrease glucose metabolism shown in human and animal research. Prins et.al 2013 In animal models second trauma during period of vulnerability (when cerebral metabolic rate of glucose (CMR_{glc}) is decreased) shows significant increase in decreased CMR_{glc}. When new mTBI is introduced after metabolic recovery the CMR_{glc} depression is similar to single injury. (1)

(1) Prins, Alexander, Giza & Hovda. **Repeated Mild Traumatic Brain Injury: Mechanism of Cerebral Vulnerability** *J of Neurotrauma* 2013
 (2) Barkhoudarian G, et al. **The Molecular Pathophysiology of Concussive Brain Injury.** *Clin Sports Med* 2011
 (3) Wei ZM, et. Al **Injury timing alters metabolic, inflammatory and function following repeated Mild Traumatic Brain Injury.** *Neurobiol Dis* 2014

Case Report Series on Vulnerability (Unpublished Data)

REPORT	Date	Game	Practice	Team	Level
Delayed Reporting	11/7/2012	20	3	12 Freshman	Practice
Delayed Reporting	10/27/2012	17	1	12 Freshman	Game
Delayed Reporting	10/19/2012	21	2	13 Freshman	Practice
Delayed Reporting	9/20/2012	100	0	0 Senior	Game
Delayed Reporting	9/20/2012	10	1	7 5TH YR SENIOR	Practice
Delayed Reporting	8/24/2012	9	0	8 Sophomores	Practice
Delayed Reporting	8/16/2012	11	2	8 5TH YR SENIOR	Practice
Delayed Reporting	8/21/2012	6	0	4 Freshman	Practice
Removed Immediately	11/20/2012	5	0	4 5TH YR SENIOR	Game
Removed Immediately	11/01/2012	3	0	0 Sophomores	Game
Removed Immediately	9/13/2012	3	0	3 Junior	Game
Removed Immediately	10/13/2012	3	0	2 Junior	Game
Removed Immediately	11/13/2012	9	0	0 Junior	Game
Removed Immediately	9/23/2012	9	1	0 Freshman	Practice
Removed Immediately	8/22/2012	5	0	4 Freshman	Practice
Removed Immediately	11/7/2012	3	0	0 Sophomores	Game
Removed Immediately	8/23/2012	7	0	0 Freshman	Practice
Removed Immediately	8/20/2012	3	0	2 Sophomores	Practice
Removed Immediately	8/15/2012	5	0	5 Junior	Practice
Removed Immediately	11/20/2012	5	1	3 Freshman	Practice
Removed Immediately	8/11/2012	3	0	4 Sophomores	Practice
Removed Immediately	11/18/2012	14	0	0 Senior	Game
Removed Immediately	8/28/2012	6	0	5 Senior	Scrimmage
Removed Immediately	11/19/2012	8	0	0 5TH YR SENIOR	Game

13.5 days to return if continued to play
5.6 days to return if immediately removed



“Rest”

Study of post-concussion activities found that both the **highest and the lowest activity levels** were associated with the **worst scores on neurocognitive testing**; those with “moderate” activity fared the best. (1)

(1) Majerske CW, Mihalik JP, Ren D, et al. Concussion in sports: postconcussive activity levels, symptoms, and neurocognitive performance. *J Athl Train*.2008;43:265-274.

Pilot Study on Strict Rest

- 99 patients age 11-22
- Trial of cognitive and physical rest versus usual care following concussion

Patients prescribed 5 days of rest had worse symptoms at 10 days post-injury

Thomas et al. **Benefits of Strict Rest After Acute Concussion: A Randomized Controlled Trial.** *Pediatric*. Feb 2015

Institute of Medicine and National Research Council of the National Academies Sports-Related Concussion in Youth October 2013

“there is little empirical evidence for the optimal degree and duration of physical rest needed to promote recovery or the best timing and approach for returning to full physical activity.”

https://iom.nationalacademies.org/~media/Files/Report%20Files/2013/Concussions/concussions-RB.pdf

Horizontal lines for notes.

“Rest”

According to Griesbach et al. animal studies suggest that properly time exercise-induced activation can beneficially affect recovery after concussive brain injuries. However, premature activation, either through forced or voluntary exercise, is deleterious to the injured brain, leading to molecular, anatomical, and behavioral deficits.

Griesbach GS, Gomez-Pinilla F, Hovda DA. Time window for voluntary exercise-induced increases in hippocampal neuroplasticity molecules after traumatic brain injury is severity dependent. J Neurotrauma 2007

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Effectiveness of Rest



3 studies showing too much activity delayed recovery = worse outcomes



2 studies show rest improves outcomes



4 studies found no association between rest and outcomes



1 study found strict rest resulted in a longer recovery

Valovich McLeod, Lewis, Whelan, Welch Bacon. J Athl Train. In press

Horizontal lines for notes.

“Rest”

- **Hypothesis** -Increase in symptoms occur during metabolic mismatch
- Determine activities that exacerbate symptoms
- Work these activities only at level that does not increase symptoms-Work below the metabolic mismatch
- Prevent secondary trauma
 - Second impact and secondary insult caused by energy deficit



Cognitive Rest

- Avoid excessive neurometabolic processes associated with cognitive activities
- Avoidance of mental challenges during the initial post-injury stage
 - Limit ADL activities
 - Limit scholastic stressors
 - Limit computer, e-mail, text, IM
 - Modify school attendance/activities



Valovich McLeod & Gioia, ATT, 2010

Cognitive Rest

slide from Tamara McLeod

No activity

Full activity



Asleep or comatose

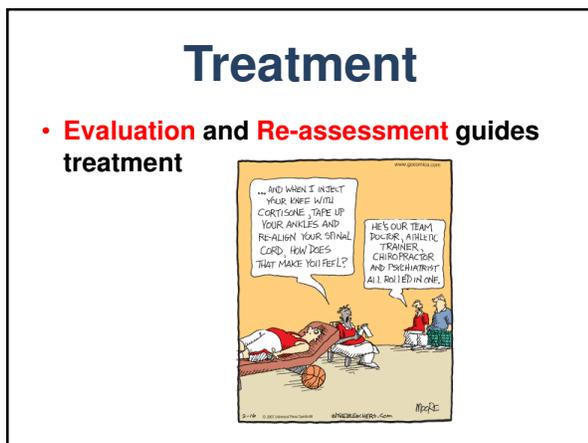


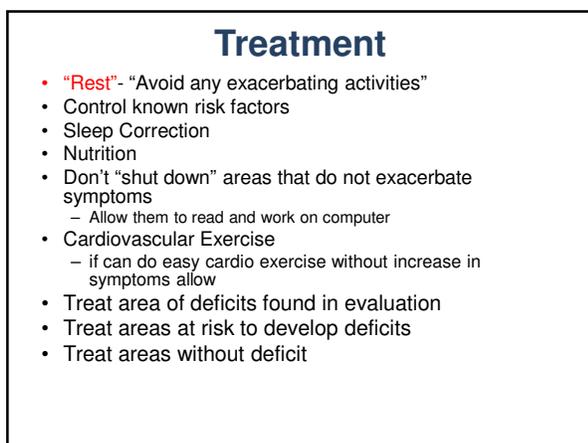
Goal: limit cognitive activity to a level that is tolerable and does not exacerbate symptoms



Normal school







Example of Exacerbating Activities to Avoid

- These will be based on evaluation and previous medical history
- **Photophobia** avoid sun- wear sunglasses different colors help different people, Lower brightness of computer.
 - **Fogginess** watch videos, tv etc.. for shorter periods of time
 - **Cognitive deficit/fatigue** avoid reading for prolonged periods
 - **Dizziness**- avoid over stimulating peripheries -large areas with people, driving in car
 - Vestibular issues- decrease early VOR overstimulation by wearing hooded sweatshirt?
 - **Anxiety**-don't isolate, normalize feelings, exercise
 - **Convergence issue**- enlarge font and move away from screen, Get off phone
 - **Cervicogenic**- posture

These need to be limited for only short period of time.
Need to implement normal activity to promote healing.

Educate to prevent this



Treatment Philosophy

Create environment to heal

Determine individual deficits-Strengthen the deficits to work as part of full system

Work full system together as soon as possible

Always work systems together with functional activity- work at lower level to not overwork the effected system (overworking will cause symptoms)

Work functional activity to build/maintain/correct motor program in brain

Sleep

- **FIRST** deficit that needs to be addressed



Sleep



- Brain regions and systems regulating arousal, alertness, attention and sleep are vulnerable to TBI (1)
- Associated with anxiety, depression and pain but does not account for all sleeping disorder after TBI (1)
- Adolescent patients with perceived sleep disturbance reported greater number of concussion symptoms & lower neurocognitive function (ImPACT) (2)
- Has negative impact on every other area
- **Sleep deficits will mimic injury to other areas that may not be present**
- Use of technology to monitor?

Assess, Educate, Treat

(1) Ponsford, J et al **Fatigue and Sleep Disturbance Following Traumatic Brain Injury—Their Nature, Causes, and Potential Treatments**. *Journal of Head Trauma Rehabilitation*. May/June 2012.
 (2) Kostyun RO et al. **Sleep Disturbance and Neurocognitive Function During the Recovery From a Sport-Related Concussion in Adolescents**. *Ann J of Sports medicine*. Dec 2014

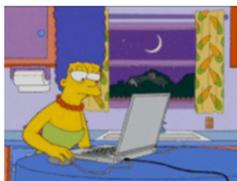
Glymphatic System

- Functional waste clearance pathway for vertebrates
- Cleanses brain of toxic molecules
- Helps control the flow of cerebrospinal fluid
- **Functions mainly during sleep.**
- Disengaged during wakefulness.
- Facilitates brainwide distribution of glucose, lipids, AA ,growth factors neuromodulators.
- Efficient elimination of soluble proteins and metabolites

Xie et al "Sleep initiated fluid flux drives metabolite clearance from the adult brain." *Science*, October 18, 2013. DOI: 10.1126/science.1241224

Sleep Correction

- If you cant sleep get out of bed
 - Keep lights low
 - Avoid any overstimulating activity-each person is different to what this is
 - Stay off electronics. If one use night modes



Create Routine

- Go to bed same time
- Get up same time
- Eat regularly at same time
- Work out consistently at same time



Sleeping Medication

Melatonin (1)

Eszopiclone

(Lunesta)

Zolpidem (Ambien)

Trazodone

Rozerem

AVOID

Neuroleptics (e.g. Seroquel)

Excess alcohol

Anticholinergics (e.g.

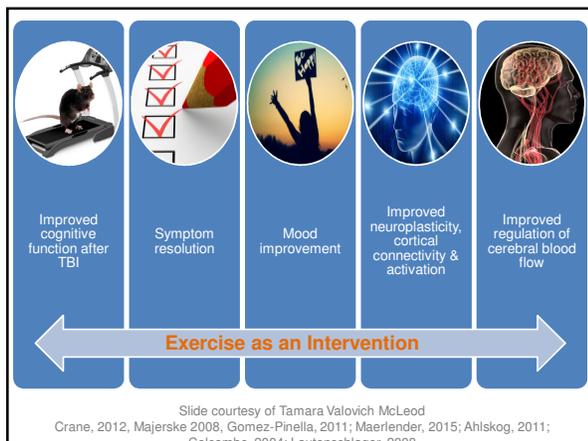
Benadryl) Benzodiazepines



"Go back to sleep, Chuck. You're just havin' a nightmare—of course, we are still in bed!"

David L. Brody MD PhD October 14, 2015
Pharmacological Management of Neurological
Sequelae of Concussive Traumatic Brain Injury

(1) Ponsford, J et.al Fatigue and Sleep Disturbance Following
Traumatic Brain Injury—Their Nature, Causes, and Potential
Treatments. Journal of Head Trauma Rehabilitation: May-June
2012



Active Rehabilitation

- Exercise has a positive effect on mental health
- There is increasing evidence that exercise has noteworthy effects on sleep/wake cycles and circadian clock modulation (Morgan et al. Journal of Molecular Psychiatry-2015)
- Closely monitored rehabilitation in post-acute phase improved recovery time in adolescents who were slow to recover (Gagnon, Brain Inj, 2009)
- Controlled sub-symptom threshold aerobic exercise improved recovery in athletes with PCS (Laddy, CJSM, 2010, 2011)

Adolescent- Early exercise vs rest on risk for PCS

- Prospective, multicenter cohort study of 3063 children and adolescents aged 5.00 to 17.99 years after propensity matching, the proportion with postconcussive symptoms at 28 days was 28.7% with participation in early physical activity vs 40.1% with conservative rest, a significant difference.
- Participation in physical activity within 1 week after injury may benefit symptom recovery following acute concussion in children and adolescents



- Grool et al 2016 **JAMA** Association Between Early Participation in Physical Activity Following Acute Concussion and Persistent Postconcussive Symptoms in Children and Adolescents

Buffalo Concussion Treadmill Test

- Test to determine exercise tolerance
 - Helps to establish physiological recovery
 - Readiness to return to activity
- Modified Balke Protocol
 - 3.6mph @ 0% incline for 1 minute
 - Increase incline by 1% each minute after
 - Until maximal incline or patient cannot complete
 - Rate of perceived exertion (RPE), HR, BP, symptoms assessed each 2 minutes
- Test is stopped with increased symptoms
 - >3 points from pre-test resting symptom score



Leddy & Willer. Use of graded exercise testing in concussion and return to activity management. *Curr Sports Med Rep* 2013

Buffalo Concussion Treadmill Test

- Good intra-rater reliability and sufficient test-retest reliability (Leddy, 2011)
- Recovery in high school athletes (Darling, 2014)
 - All athletes returned to sport without symptom exacerbation or recurrent symptoms
 - 48% had one or more CNT sub-scores below average
 - BCTT better predicted readiness to begin RTP protocol

Buffalo Concussion Treadmill Test

- Assists with differential diagnosis (Leddy, 2013)
- Patients with concussion stop at submaximal level
 - If able to exercise to exhaustion without replicating symptoms then symptoms not due to

Diagnosis	Physiologic PCD	Cervicogenic PCD	Migraine PCD	Affective PCD	Vestibulo/Ocular PCD
BCTT response	District submaximal symptom limited threshold characterized by complaints of sudden increase in lightheadedness, headache, head pressure, or "fullness" of the head.	No district symptom limited threshold. Able to exercise to exhaustion. Posterior headache that improves early in exercise but often returns near exhaustion.	BCTT not performed if migraine present. If migraine not present, there is no district symptom limited threshold. Able to exercise to exhaustion.	No district symptom limited threshold. Able to exercise to exhaustion. Head usually improves with exercise testing.	No district symptom limited threshold. Able to exercise to exhaustion. Symptoms are usually visual blurred vision, difficulty with focusing or mild lightheadedness. Vertigo typically is not reported during the test.
Physical exam	May have orthostatic drop in BP and or rise in HR.	Cervical muscle tenderness and/or spasm, reduced motion, altered cervical proprioception, suboccipital tenderness	Exam usually normal when not symptomatic. May have photosensitivity.	May have flat or depressed affect.	Discomfort (and sometimes nystagmus) with ocular smooth pursuits and saccades, abnormal ocular convergence 1-6 cm, abnormal VOR, positive findings and abnormal tendon gait.

*VOR, vestibulo-ocular reflex; BCTT, Buffalo Concussion Treadmill Test; PCD, post concussion disorder.

Treatments Examples

- Anxiety with Vestibular involvement exercising in stimulating environment will cause migraine
 - Introduce exercise in low vestibular stimulating environment
- Anxiety or oculomotor issue without vestibular-(ImPACT will not have visual motor deficits) Exercise Hard.

Nutrition

- Anti-inflammatory diet
- Fish Oil-DHA or EPA&DHA (3)
- Proper Hydration (2)
- Avoidance of alcohol
- Adequate Complex Carbohydrates during recovery to offset the Metabolic Demand for glucose?
- Ketogenic Diet? (1)

Strong data is not currently available to the benefit

- These recommendations are universal and will have overall health benefits
- Newer Evidence-exercise in combination with dietary factors, have an affect on molecular event related to the management of energy metabolism and synaptic plasticity. (4)

(1)Prins ML, Matsumoto JH. The collective therapeutic potential of cerebral ketone metabolism in traumatic brain injury. *Journal of Lipid Research* (2014)
 (2) Spjut M, Weerkamp N, Troost J, van Schayck CP, Knoltnerus JA A randomized trial on the effects of regular water intake in patients with recurrent headaches. *Family Practice* 2012
 (3) Bailes JE, Patel V. The potential for DHA to mitigate mild traumatic brain injury. *Military Medicine* 2014
 (4) Gomez-Pinilla, F. The combined effects of exercise and foods in preventing neurological and cognitive disorders. *Prev Med* 2011

Omega 3



If you are uncertain that you are not taking too much, please seek medical consultation from your healthcare provider for dosing.

This information is not intended to replace the advice of a healthcare professional. It is for informational purposes only. It is not intended to be used as a substitute for professional medical advice, diagnosis, or treatment. Always seek the advice of your physician or other qualified health provider with any questions you may have regarding a medical condition.

STEP 1: Begin a high quality fish oil supplement—start off with 1 to 2 grams

- The purpose of this step is to establish a baseline of omega-3 intake and to begin to address any existing deficiencies.
- For patients with low omega-3 intake, start with 1 gram (1000 mg) of high quality fish oil supplement daily for 2 weeks.
- If you are already taking a high quality supplement for fish, then consider increasing your intake to 1 to 2 grams daily.
- For patients with high omega-3 intake, start with 1 gram (1000 mg) of high quality fish oil supplement daily for 2 weeks.
- "High quality" means that the supplement is derived from wild-caught fish and is free of contaminants.

STEP 2: Begin taking your omega 3s as soon as possible following an injury or illness

Week 1:

- Take 2 grams of 1000mg capsules a day for 7 days (2 capsules twice a day) or before work or school, at the end of the day.
- For patients with low omega-3 intake, start with 1 gram (1000 mg) of high quality fish oil supplement daily for 2 weeks.

Week 2:

- Take 2 grams of 1000mg capsules a day for 7 days.

STEP 3: Continue with a maintenance dose to maintain optimal brain health

Maintenance Dose: Continue with 1 gram (1000 mg) daily.

www.brainhealtheducation.org

Nutrition

- Glucose not stored in brain
- Need to have consistent glucose levels
- Need to keep this level up
- Higher demand energy system damaged so not as efficient
- Eat every 2 hours to prevent a deficit
- Eat complex carbohydrates for energy
- Anti-inflammatory diet

Anti-inflammatory Food Pyramid

<http://www.drweil.com/drw/u/PAG00361/anti-inflammatory-food-pyramid.html>



Psychological Disorders Anxiety/Mood

- In a study looking at patients who were still symptomatic at 3 month Ponsford et al states managing the anxiety response in vulnerable individuals (patients with a pre-injury psychiatric history) with mTBI may be important to minimize ongoing sequelae.(2)
- Mild Traumatic Brain Injury leaves patient at risk for developing anxiety disorders. A potential molecular mechanism has been shown in rodent models (1)
- Emotional disturbance after **concussion** is **different than** emotional disturbance after **musculoskeletal injury** at 2 weeks in college aged athletes. (3)

(1) Rager et al. Concussive Brain Injury Enhances Fear Learning and Excitatory Processes in the Amygdala. *Biological Psychiatry* 2012
 (2) Ponsford J, et al. Predictors of Postconcussive Symptoms 3 Months after Mild Traumatic Brain Injury. *Neuropsychology* 2012
 (3) Hutchinson M, et al. Differential emotional responses of varsity athletes to concussion and musculoskeletal injuries. *Clin J Sports Med* 2009

Psychological Disorders Anxiety/Mood

Evaluation (1)

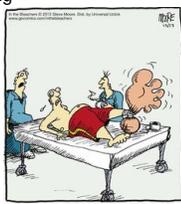
- Risk Factors-Persona/Family history of anxiety
- Symptoms-ruminative thoughts (compulsively focused attention on symptoms), hypervigilant, feelings of being overwhelmed, sadness, and/or hopelessness.
- Sleep disorders
- Strong co-occurrence with vestibular dysfunction
- Wake up in morning with headache
- If **lacking vestibular** component **neurocognitive tests** results may be **normal**
- Referral-Psychiatrist, Psychologist

Collins MW et al., **A comprehensive, targeted approach to the clinical care of athletes following sport-related concussion.** *Knee Surg Sports Traumatol Arthrosc* 2014

Psychological Disorders Anxiety/Mood

Evaluation Questions

- How often do you symptoms inventory?
- Do you have difficult time turning off your thoughts?
- Do you become symptomatic when thinking about your symptoms?
- Have social activities been restricted?
- Do you feel you have been missing out of activities because of symptoms?
- Do you have headache in morning?



From Michael Collins

Psychological Disorders Anxiety/Mood

- Cognitive Restructuring (1)-Cognitive Behavior Intervention have shown improvements in general anxiety, depression and a transient mood measure, tension-anxiety following acquired brain injury (2)
- Patients with anxiety often do better when **provided with structure** and this type of regimented schedule will help to regulate autonomic functioning and again, speed recovery. (3)
- **Normalizing feelings**
- **Aggressive exercise therapy** if lacking vestibular component
- Mood stabilizing medication

(1) Giza et al. **Summary of evidence-based guideline update: Evaluation and management of concussion in sports.** *Neurology* 2013
 (2) Hodgson, S. et al. **A Randomised Controlled Trial of a Cognitive-Behavioural Therapy Program for Managing Social Anxiety After Acquired Brain Injury.** *Brain Injuries*. 2005
 (3) Collins MW et al., **A comprehensive, targeted approach to the clinical care of athletes following sport-related concussion.** *Knee Surg Sports Traumatol Arthrosc* 2014

Learn about the difference between TBI and PTSD along with some overlapping symptoms

[pic.twitter.com/6icX8bOW/E](https://twitter.com/6icX8bOW/E)
Slide from Dr. Joseph Maroon @Dr.JosephMaroon

Overlapping Symptoms

Possible Symptoms of TBI	<ul style="list-style-type: none">• fatigue• sleep problems• trouble with memory and attention• feeling depressed• feeling anxious• irritability	Possible Symptoms of PTSD
<ul style="list-style-type: none">• headaches• dizziness/balance problems• nausea• sensitivity to light and sound• vision changes• impulsivity		<ul style="list-style-type: none">• on high alert• startled easily• fearfulness• flashbacks• nightmares• guilty feelings• avoidance• numbness• self-destructive behavior

Anxiety Issues

- Psychosocial risk of treatment
- Need to know if being at practice, meetings etc... causes stress or relieves stress
- Need to understand stress of removing from social environment
- Individualized patient centered care



Cervicogenic Treatment

- Postural Assessment and Correction
- Manual Therapy
- Soft Tissue Assessment and Treatment- IASTM
- Modalities
- Range of Motion/Muscle Stretching
- Muscle Strength, Endurance and Activation
- Physical Conditioning
- Biofeedback
- Breathing Pattern
- Trigger Point Treatment



Page, P. Cervicogenic Headaches: An Evidence-Led Approach to Clinical Management. *In J of Sports Physical Therapy*. 2011

Traumatic Headache/Migraine

- **Risk Factors:** History or family history of migraines. History of anxiety?
- **Symptoms:** variable headaches and intermittently severe, nausea with photo & phonosensitivity
- Migraines may be caused by vestibular dysfunction. Treat vestibular dysfunction
- Headache classification after TBI. Migraine/probable migraine, tension type, cervicogenic (1)
- Migraine was most frequent type (1)
- Post Traumatic Migraine-Headache, nausea, photosensitivity, phonosensitivity (2)
- Acute Migraine vs Chronic Migraines
- Chronic migraine-referral for assessment for prophylaxis medication

1. Lucas S, et al. **Characterization of headache after traumatic brain injury.** *Cephalalgia* 2012
 2. Kontos, AP, et al. **Posttraumatic migraine as a predictor of recovery and cognitive impairment after sport-related concussion.** *Am J Sports Med* 2013

Cognitive Fatigue

- Risk Factor-**Hx of learning disability/ADHD
Symptoms-Fatigue, General HA, End of Day Symptoms
VOMS- Normal
Neurocognitive Test (IMPACT)-Global deficits
Questions:
- Do you have general HA that increases as day progresses?
 - Do you have more fatigue at end of day?
 - Do you feel more distractible in school?
 - Have you pushed through symptoms?

End of Day Fatigue without Oculomotor Deficits

Cognitive Fatigue

- **DO NOT LET THEM PUSH THRU THIS**
- Physical/Cognitive Breaks throughout day
- Monitoring activity/exertion
- Stimulant medications?
- Monitor the Type A personality!!!



Cognitive Fatigue

- Cognitive Rehabilitation/Therapy if needed
- Stimulate then recover
- Fuel the system



Vestibular Rehabilitation



Vestibular System

Slide courtesy of Bridgett Wallace

Peripheral

- Bony and membranous labyrinth
- Signal begins, transformed into an electric signal and sent to the central system

Central

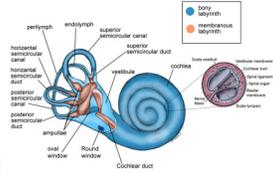
- Vestibular nuclei, cerebellum, cortex
- Signals are processed, interpreted, and integrated with other sensory cues

Motor Output

- Oculomotor: Gaze stabilization
- Vestibulospinal: Postural control

Peripheral Sensory Apparatus

- Bony Labyrinth
 - Semi-circular canals
 - Cochlea
 - Vestibule
- Membranous labyrinth
 - Membranous portion of semi-circular canals
 - Otolith organs
 - Utricle
 - Saccule



Vestibular Function

- Detection of angular and linear acceleration
- Relation of head with respect to gravity
- Functional outcomes
 - Ocular: gaze stabilization
 - Vestibulospinal: contribution to postural control



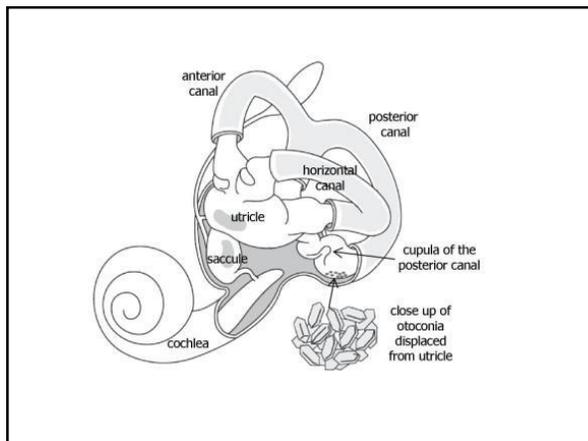
Vestibular Reflexes

- Vestibulo-ocular reflex (VOR)
 - Generates eye movements that enable clear vision when the head is moving
- Vestibulocollic reflex (VCR)
 - Acts on neck musculature to stabilize the head
- Vestibulospinal reflex (VSR)
 - Generates compensatory body movements to maintain head and postural stability (i.e. prevent falls)

Benign Paroxysmal Positional Vertigo BPPV

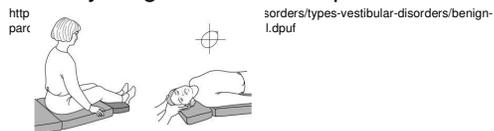
- Displaced otoconia (calcium carbonate crystals) in posterior semicircular canal
- Produces a transient positional nystagmus
- Benign – it is not life-threatening
- Paroxysmal – it comes in sudden, brief spells
- Positional – it gets triggered by certain head positions or movements
- Vertigo – a false sense of rotational movement

www.vestibular.org; Shumway-Cook, Ch 27, Vestibular



BPPV

- Transient vertigo
 - Spinning sensation mainly when changing positions
 - Laying down or rolling in bed
 - Brief in duration
 - Uncommon in children and adolescents
- Easily diagnosed: Dix Hallpike



Shumway-Cook, Ch 27, Vestibular

BPPV

Quickly correctable

- Canalith Repositioning Maneuvers
- Immediately resolved

THE EPLEY MANEUVER

Redistributes particles. Particles in semicircular canal.

The head may be rapidly turned away further to almost face the floor. The patient is returned to the upright position and the head is straightened to neutral.

The clinician explains that patient's head toward the affected ear, then lower the patient's head to the floor position with the neck hanging over the table's edge.

The head is turned further, so that the ear is parallel to the floor.

The head is turned to the other side.

Vestibular Rehabilitation After Concussion

Intervention	Outcomes
<ul style="list-style-type: none"> • Gaze stabilization (X1) • Standing balance • Walking with balance challenges • Canilith repositioning 	<ul style="list-style-type: none"> • ↓ Dizziness rating • ↑ Activities-specific balance confidence scale • ↓ Dizziness Handicap Inventory (DHI) • ↑ Dynamic gait index • ↑ Functional gait assessment • ↓ Timed up and Go (TUG) • ↑ Sensory Organization Test-SOT (all conditions)

Alsalaheen, JMPT, 2010

STEP WISE APPROACH: Visual-Vestibular

117

```

graph LR
    A[Static Head & Target] --> B[Static Head, Dynamic Target]
    B --> C[Dynamic Head, Static Target]
    C --> D[Dynamic Head, Dynamic Target]
    
```

Continue increasing demand as symptoms decrease with each new demand.

Courtesy of Bridgett Wallace PT Presentation 2016

STEP WISE APPROACH: Visual-Vestibular

118

Continue increasing demand as symptoms decrease with each new demand.

Bridgett Wallace PT Presentation 2016

STEP WISE APPROACH: Visual-Vestibular

119

Continue increasing demand as symptoms decrease with each new demand.

Bridgett Wallace PT- Presentation 2016

Treatment for ingrained vestibular issues

- Vestibular suppressants (short term basis)
 - Anticholinergics
 - Antihistamines
 - Benzodiazapines
- Balance Rehabilitation Therapy (BRT)
 - Vestibular rehabilitation

Henrie & Elovic. Somatic Manifestations of mTBI. In: Manual of TBI Management. 2011.

Traditional Indications for Vestibular Therapy

- **Atypical Recovery**
 - Not back to baseline on balance assessment by 10 days post-concussion
 - Impaired dynamic visual acuity tests
 - Dizziness
 - Motion provoked dizziness
 - Nausea
 - Blurred vision with head movement
 - Motion sensitivity

Kevi Ames, PT, DPT

Indications for Vestibular Rehabilitation Concussion Clinic

- **Symptoms**
 - Vertigo (especially when lying in bed)
 - Dizziness/ imbalance
 - No improvement over one week or is persistent beyond two weeks
- **Balance impairments**
 - Strong Romberg (after one week)
 - BESS
 - ↑ BL after 1 wk or > 10 errors per set, > 30 total after 1 wk
- **+ Dix Hallpike**
 - +/- improvement or resolution with Epley maneuver
- **Patients generally like the active nature of participating in their recovery**

Javier Cardenas, MD

Examples of Vestibular Exercises

- **Gaze Stabilization-** eyes fixed stationary object move head side to side & up/down
- **Smooth Pursuit-** eyes fixed on target. Move target side to side & up/down or 2 targets apart move eyes between 2 targets (side to side & up/down)
- **Head and eyes same direction** -fix eyes on target (ie thumb) move target (side to side & up/down) head & eyes in same position
- **Head and eye opposite direction** -fix eyes move target and head in opposite direction

Remembered Target Exercise

- Patient fixates on a small target
- Closes eyes, pretending to look at that target
- Patient makes a horizontal head movement, trying to remember where the target is
- Opens eyes to check whether or not they are still looking at the target
- Aims to foster central pre-programming of eye movements

Rehabilitation Strategies for Ingrained Problem

- Adaptation
 - Ability of the vestibular system to make long-term changes in the neuronal response to input
- Substitution
 - Using other strategies to replace lost function
- Habituation
 - Reduction in symptoms produced through repeated exposure to the movement

X2/VORx2Vestibular Exercises

- Target and the head move in opposite directions
- Patient focuses on target
- **Errors**
 - Similar to X1 errors
 - Confusion when trying to move head and target in opposite directions
 - Results in VOR cancellation

<https://www.youtube.com/watch?v=0Ca1iCkwlcM>

Dual Task Strategies

- Combined postural control and cognitive tasks
- Retrain executive attentional networks
- Secondary cognitive activities improve postural control (Wulf, 2001; Huxhold, 2006; Resch, 2011)



Vestibular Exercise Progressions





BIODEX



Oculomotor Disorder

- Treatment
 - Oculomotor retraining / rehabilitation
- Prevention
 - Pre-season vision training
 - Exploratory study out of University of Cincinnati shows decrease in concussion rate (9.2 vs. 1.4 concussion/100 player seasons) after preseason vision training (Clark, 2015)

Convergence Insufficiency

- Inability to maintain binocular function (keeping the two eyes working together) while working at a near distance
 - Typically, one eye will turn outward (intermittent exotropia) when focusing on a word or object at near
- Symptoms
 - Diplopia & Headaches when reading
 - Difficulty concentrating on near work (computer, reading, etc.)
 - Written word blurs after prolonged periods of reading or if reading when tired
- Remote near point of convergence
 - Maintain binocular fixation on a fusalional target up to at least 6 cm from the tip of the nose

Effectiveness of Oculomotor Rehab

- Patients with long term issues
- Vergence-based oculomotor rehabilitation was effective in individuals with mTBI who reported near work-related symptoms
- Overall improvement in nearly all of the critical, abnormal measures of vergence was observed both objectively and clinically (Thiagarajan, 2013)



10 Must Have Vision Therapy Techniques for PT

Convergence Insufficiency	Oculomotor Dysfunction
Pencil Push Ups/Wolff Wands	HART Chart [saccade]
Pointer and Straw	Marsden Ball [pursuit]
Brock String	Rotator Pegboard [pursuit]
3 Dot Card	Michigan Tracking [saccade]
Life Saver Card	Thumb pursuits and saccades



Pencil Push Ups

Step 1

-Hold a pencil on front of you at arm's length. The pencil should be vertical, with the tip of the sharpened pencil at the top. The pencil should be directly in front of your face, with the tip just below eye level.

Step 2

- Move the pencil slowly toward your face as you concentrate and focus on the point. Soon you'll notice that you see two pencils rather than one. Stop.

Step 3

- Look away from the pencil briefly to rest your eyes. Focus on something across the room for two or three seconds, and then look back at the pencil point where you've stopped it close to your face. Look at the pencil point carefully, and to try to focus so that the double vision disappears and you only see one pencil.

Step 4

- Move the pencil back out to arm's length when you are able to rid yourself of double vision. If this takes more than a few seconds, look away and try again. Once you are able to accomplish it, move the pencil back out to arm's length and complete the exercise again.

Step 5

- Do the pencil pushups for 10 minutes, continuing to move the pencil back and forth in front of your face. Talk to your optometrist if the treatment doesn't help your convergence insufficiency.



Brock String

Brock String

1. Tie or hold one end at eye level. The patient is to hold the other end to their nose so they can look down the string at a target head.
2. At first the heads should be placed much closer than the green head is 14 inches from the participant nose. The yellow head is about 10 inches from the participant nose and the red head is about 7 inches from the participant nose. The distance of the heads do not have to be exact. The green head should be placed at a comfortable eye the patient's eye-gaze distance. A comfortable eye-gaze distance is a little further (more eye inches) than the normal reading distance.
3. The patient is instructed to look at the yellow head. The assistant makes sure that both eyes are looking at the yellow head and appear to both be coming at the head. If the eyes are working together, the participant will see an optical illusion of one yellow head, two green heads and one red head.

Instructions may be similar to: "Look down the string at the yellow head. When your eyes are in focus together they should see one yellow head, two red heads and two green heads. Please let me know when you see this."



4. Have the patient shift the focus to the red head so that the participant sees one red head and two of the others.
5. Have the participant shift the focus to the green head so that the participant sees one green head and two of the others.
6. Have participant go from the green head, to the yellow head to the red head, to the yellow head and to the green head, just practicing alternating their focus to the different lengths. Watch the participant's eyes so they appear to be converging at the correct spot.
7. Over time and over multiple sessions, continue moving the green head until convergence is comfortably reached at 6 to 8 inches from the nose.

Helpful Hint: If you notice that one eye is looking at the correct head and the other eye is not. Put an index card over the dominant eye and instruct the participant to look at the correct head and concentrate on looking at the correct head. While the participant is looking at the correct head, slowly move the index card away from the dominant eye. If done correctly both eyes will be on the correct head and the participant will report that they see two of each of the other heads and one of the correct head.

<http://www.yourfamilyclinic.com/ND/vision/brock.html>

Brock String

Talk to them during this

Teach this to be "reflexive" without need to concentrate



Horizontal and Vertical Saccades

- Many exercises
 - Maze
 - Number saccades
 - 4 square saccades
- Standing Tennis ball Toss and Catch
 - Waist level
 - Shoulder level



Mardsen Ball



Eye Charts



- Move back and forth between charts at different depths
- Use patterns
- Say color or say direction

Oculomotor

- May have NPC normal but can they keep it?
- Difficulty reading to writing
- Reading notes- Increase symptoms

Treatment Techniques

- Read note out loud. Get auditory learning
- Listen to recordings of lecture to allow studying longer without increase in symptoms
- Train shorter periods more often 5-10 min
- Morning is better. End of day fatigue will effect rehab
- Exercise may help decrease symptoms

Oculomotor exercise progression

- Saccades
 - Shorter distance apart predictable to faster different distance
 - Slower speed to faster speed
 - Simple background to complex
 - Steady surface to unsteady
 - Head steady to head movement
 - Work to functional sports specific

Combination Oculomotor & Cervicogenic

- Increase symptoms with Oculomotor activity
 - Posture, Heads stability?
- Attempt Oculomotor exercises supine
 - Pencil push ups
 - Ball Toss and Catch. Up and down, off wall
- Combined Cervical Stability and Oculomotor activity
 - Push ups with charting or reading material on ground. Straight below or off to side

Migraine/Post Traumatic Migraine

- Is it primary?
- Is it secondary from sleep issues, vestibular, ocular, anxiety, cervicogenic?
- Fix all secondary issues
- **Primary**-don't exert thru.
- Referral to specialist- Medication need assessment.



Reaction Time Training



Incorporate hand, eye, feet, core stability, head motion etc...

Sport Reaction Time

Stimuli Seeing or Sensing

↓

Recognize Stimuli

↓

Reflexively &/or Cognitively React

↓

Move Feet, Trunk, Head to correct position

↓

Hands are in right position to do something

Reaction time training in rehab



- Progress to sport specific training
- Even if still having symptoms
 - No risk of contact
 - Symptoms do not increase with activity

External Focus – Agility Testing/Training



Add video of tennis ex that parker was doing

Returning to Participation



Early addition of sports specific activity

- Importance of adding sport back early
- Key- Add sport **without risk of contact**. Progressively adding sport back even with symptoms as long as symptoms do not increase.
- Psychological benefit of not isolating
- **Sport trains ocular motor, vestibular, reaction time, cognitive systems**



"It's safe to look, sir. There's a time-out on the battlefield. Our athletic trainer is taping up Sir Dwayne's twisted ankle."

Reaction time in sport

What is reaction time in sport?

- Can it be measured with computer test?
- Can it be measured with finger or hand tests?
- Can it be measured with hand touching lights?



Sport Reaction Time

Stimuli Seeing or Sensing



Recognize Stimuli



Reflexively &/or Cognitively React



Move Feet, Trunk, Head to correct position



Hands are in right position to do something

Return to Play

- New data looking at return to play is not 1-2 weeks but is looking like 3-4 weeks. (1)
- UA Data 2014-2016 seasons 11 days average for concussions that returned during the season
- **INFORMED CONSENT**- Physicians (ATs) have a duty to provide athletes and their parents with information about concussion risk factors, symptoms, and the risks for post-concussion neurologic impairments. (2)
- Knowing your patients



"Ho ho ho, BFF. Guess what? After we go to the dugout and the press office, I'm going to the vet to get treated!"

(1) Henry LC, et al. **Examining Recovery Trajectories After Sport-Related Concussion With a Multimodal Clinical Assessment Approach.** *Neurosurgery*. 2015
 (2) Kirschen M, et al. **Legal and ethical implications in the evaluation and management of sports-related concussion.** *Neurology* 2014

Evaluation for Clearance

- Symptom Score
- Vestibular Ocular Assessment
- Vestibular Spinal Assessment
- Ocular Assessment
- Vital Signs
 - HR & Blood Pressure for orthostasis
 - Heart rate variability
- Exercise Stress Test
- Cardio Endurance Stress Test (HRV?)

Evaluation for Clearance (Cont)

- Cervical Extensor Endurance Test (1)
- Reaction Time Assessment*
- Neuropsychological Assessment
- Sport Progression Non-contact to Contact
- Performance Assessment
- **Informed Consent- Patient wants to return**
- **Acknowledge sport difference. Risk of contact**

(1) Sebastian D. et al **Cervical extensor endurance test: a reliability study.** *J Bodyw Mov Ther* 2015 Apr 19

Continuing Rehab after return?

- Is sport specific activity enough?
- Monitor productivity on the field/court/sport
- Continuing with vestibular, ocular therapy & reaction time training?



Advanced Rehab

- Brain injury is very complex
- Advanced rehab needs to be very advanced



Early Treatment Approach

- Determine what will cause symptoms
- Introduce Cardiovascular Conditioning early
- Train areas without deficits- Can we prevent further issue?
- Initially rest- **how long is the million dollar question**
- Then work into activities that exacerbate symptoms
- You may (and probably should) cause increase in symptoms with treatment. **Expose then recover.** Control level of activities

You wont know how far you can progress until you go a little to far. This is OK as long as you do risk with contact



Re-assess after they have returned?

- Monitoring and documenting symptoms score after the patient has returned
- Other assessment needed?
- Sport performance assessment documentation



Recommendations for AT

- Set up treatment team- May need to look at telemedicine
- Communicate with treatment team
 - What are specific sign/symptoms/evaluation findings the would require referral to specialist. Discuss time frame of referral recommendation.
 - What can you implement on your owns as AT, Primary care physician and when can you implement?
- Education of athletes to be **"HONEST"**. This is key to treatment
 - "I will make you worse with treatment and progression if you are not honest with me about symptoms"
 - Document this education

Recommendations for AT

- Know your patients goals. Support their goals. Patient Centered Care
- Educate other healthcare providers. They do not know this information. Strict rest is doing harm. Educate on avoiding self medicating
- Assess for drug use (opiates & marijuana) for athletes with diagnosed and undiagnosed concussion
- Early addressing of vestibular ocular, cognitive fatigue and psychological issues-Data starting to point that PCS have high prevalence of these issues

Specialist with publications to watch

- Overall Treatment- Michaels Collins, Anthony Kontos...UPMC Group
- Physiology-Chris Giza- UCLA Brain Inj Research Center
- Vestibular Therapy Bridgett Wallace, Shelly Massingale,
- Leddy- Exercise therapy
- William Padilla, Charlie Shearer OD. Oculomotor Rehab



Thank You



The "End"
