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Sports Related Concussion: Updates and Innovation

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Disclosures

I have no financial interests or relationships to disclose.



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NATIONAL
ATHLETIC
TRAINING
MONTH

**There's An
AT For That**

MARCH 2023



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Morahan CAARP™

Comprehensive
Academic
Active
Recovery
Plan



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2022 International Conference on Concussion and Sport

The Morahan Center had two accepted abstracts for publication/presentation at the 2022 International Conference in held this past October in Amsterdam!

Abstract # 1 :The effectiveness of the **Morahan CAARP™** algorithm of care on **patient outcomes showed improvement in recovery timelines from initial evaluation to discharge (11.5 days).**

Abstract # 2 : The safe approach for treadmill testing utilizing the Morahan Pediatric Concussion Exercise Tolerance Test (MPCETT) showing 0 adverse events.



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Sports Related Concussion

NATA

The 2014 National Athletic Trainers' Association (NATA) position statement on the management of sport-related concussion (SRC) defines *concussion* as a brain injury resulting from biomechanical forces producing a complex **pathophysiological** process that typically results in the rapid onset of short-lived **impairment of neurologic function** that resolves spontaneously.

Berlin

- ▶ SRC may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an **impulsive force** transmitted to the head.
- ▶ SRC typically results in the rapid onset of short-lived **impairment of neurological function** that resolves spontaneously.
 - ▶ SRC may result in neuropathological changes, but the acute clinical signs and symptoms largely reflect a **functional disturbance** rather than a structural injury.
 - ▶ SRC results in a range of clinical signs and symptoms that may or may not involve loss of consciousness.



BERLIN VS AMSTERDAM

5TH INTERNATIONAL CONCUSSION CONFERENCE IN SPORT (Berlin) CONSENSUS STATEMENT vs 6th ***INTERNATIONAL CONCUSSION CONFERENCE (Amsterdam)***

Newest changes BERLIN

- Complete cognitive rest not validated after 48 hours
- Symptom threshold through activity/cognition in acute phase
- Focus on categories for recovery (ocular-motor/cognitive/exercise threshold/cervical)
- Defining PCS in children (>4 weeks with symptoms)

Newest changes AMSTERDAM

High emphasis on evaluation

- Scat 6 (Coming Soon) – Higher Memory Thresholds (7-10 words)
- Modified Bess
- Dual Tasking/Tandem Gait
- Measurable scales: Physical activity readiness questionnaire, Readiness to RTP, Symptom measurables (Scores correlating to PCS trending)
- Behavioral/ Cognitive readiness



Measuring Functional Disturbance

The three most common and most frequently used measures are **functional Magnetic Resonance Imaging (fMRI)**, **magnetoencephalography (MEG)** and **electroencephalography (EEG)**. Of these methods, EEG is the most versatile and cost-efficient solution



LEDDY LEADS THE CHARGE (University of Buffalo)

The scoop on CBF

- Cerebral blood flow increases during exercise
- Following concussion we typically see a loss of CBF control
- With deconditioning we also see a natural loss of control with CBF causing fatigue, slowed cognition, symptoms, inability to exercise to max capacity and abnormal elevations in CBF; negative effect on autoregulation.

How do we improve CBF?

- Exercise can improve CBF by calculating 80%-90% of symptom threshold or by increasing THR 5-10 bpm every 1-2 weeks.
- SLOWER EXERCISE TOLERANCE=SLOWER RECOVERY

New methods

Activate autonomic NS early on and try to help restore CBF through early activity such as low level movements to maintain conditioning (light walking, jogging, biking). Avoid weight training till final stages of RTP.

Berlin states, “ closely monitored active rehabilitation programs involving controlled sub-symptom threshold, submaximal exercise have been shown to be safe and may be of benefit in facilitating recovery.”

SO HOW MUCH IS TOO MUCH?

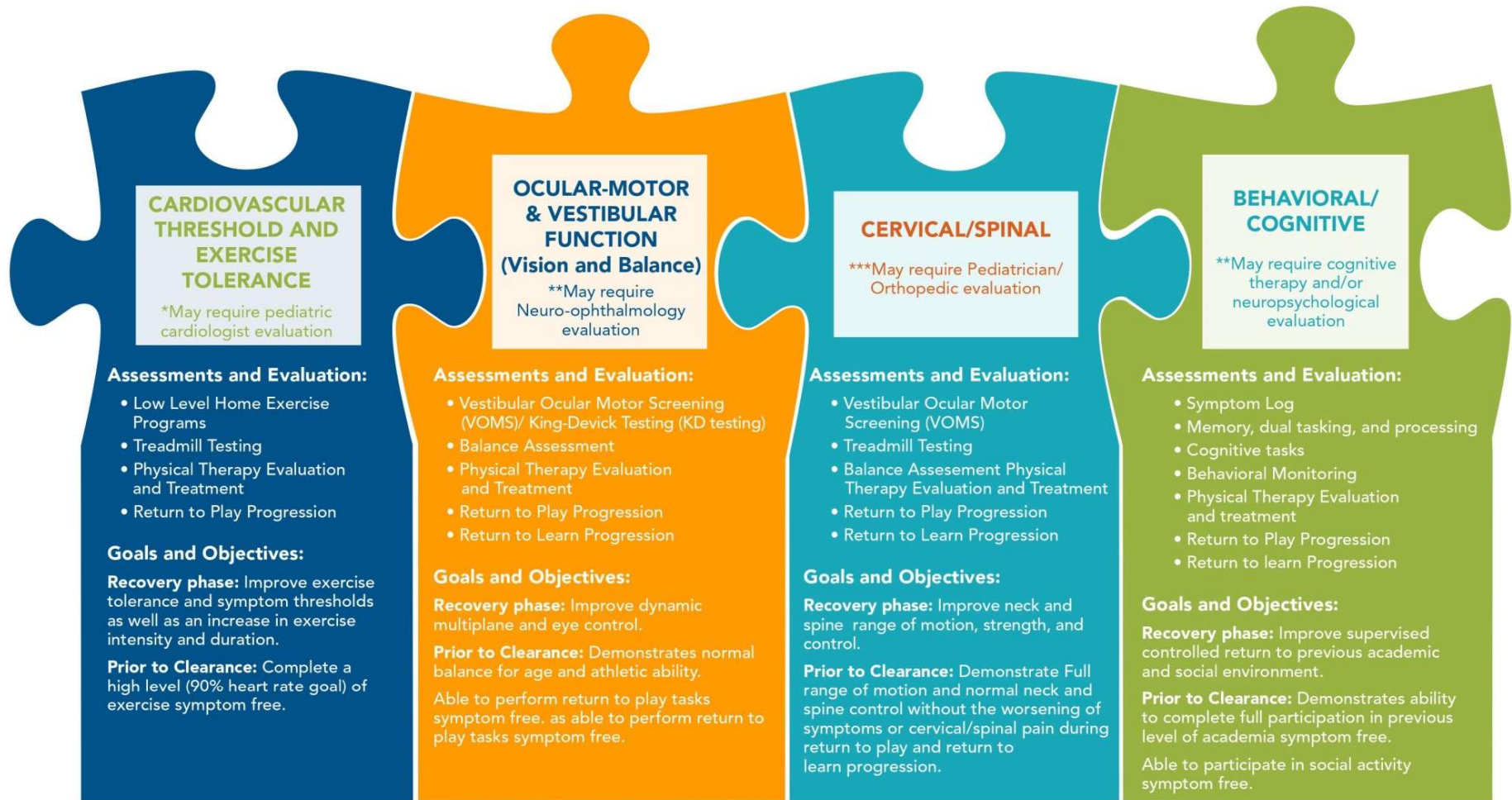


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Concussion Pillars for Recovery

ALL PILLAR GOALS MUST BE ACCOMPLISHED PRIOR TO CLEARANCE TO RETURN TO FULL ACADEMICS AND SPORT.

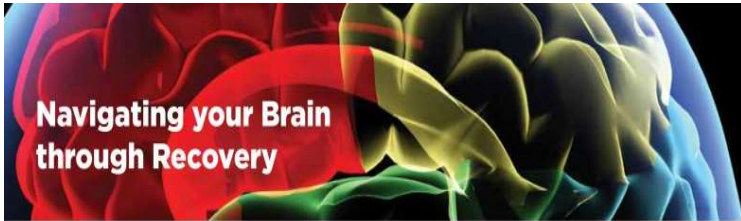


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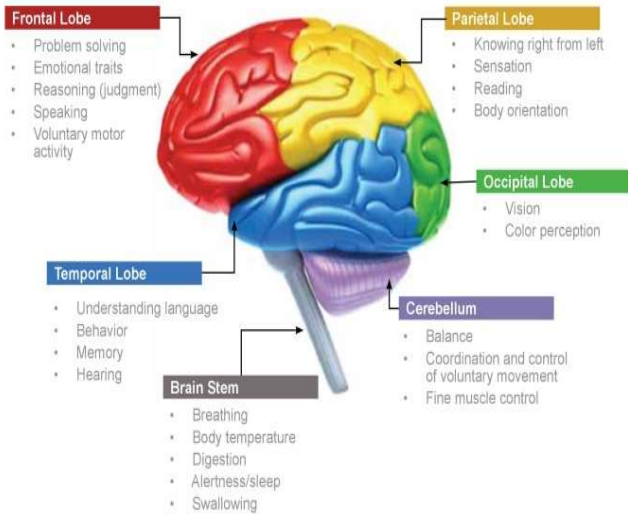
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Let's be healthy together.

What's in your tool kit; Inducing vs Reducing Symptomatology



Navigating your Brain through Recovery

Without a true diagnostic tool, blood biomarker or special imaging (MRI, CT) that can diagnose concussion, clinicians have to rely on tools to assess different areas of the brain to determine any potential functions of the brain that can be compromised. Your brain supports every movement and major function in life including functions as crucial as the ability to breathe. Each lobe of the brain is responsible for different roles such as speech, reading, distinguishing between colors, balance, coordination, sleep, memory, behavior, and hearing. At the Morahan Center see how we are combating second impact syndrome by assessing every aspect of your brain.



Every brain heals at a different pace and over a different time span. Some brains can take weeks or months to heal, while others can experience long term symptoms that last years and even decades. The rate of recovery can be altered by psychological issues, Attention Deficit Hyperactivity Disorder (ADHD), gender, and other variable factors. Recovery is generally extended with every repeat injury or with a multiple concussion history as well as with patients or athletes that fail to report symptoms honestly or follow school accommodations or restrictions. It is very important to report symptoms honestly for this reason. Avoiding long term issues following a brain injury is largely dependent on ensuring the first concussion heals correctly. During a concussion one or several areas of the brain can be affected. Each area of the brain controls different functions for movement, motor skills, coordination, vision and daily function. Our colored brain map addresses each area of your brain and the ability to assess, track improvement, and map recovery of every brain injury with an individualized plan of care.

Areas of the Brain Testing Targets	Testing Type	Appropriate Ages	Testing Facts
Frontal Lobe Occipital Lobe Parietal Lobe Cerebellum	King-Devick Testing	5 and up	50% of the brain's pathways are tied to vision. Following a suspected brain injury, the King-Devick (KD) Test tracks Saccadic Eye Movements and asks participants to read numbers from left to right. Baseline testing prior to an injury, includes several timed trials measuring eye speed as the participant verbalizes numbers aloud. The total time of all three cards (cards two through 4) without errors becomes the participant's baseline. Significant delay in eye movement speed and an increase in errors recorded is a significant change that can be found post-concussion when compared to baseline. This deficit may be detected in the acute phase following a suspected Brain Injury. The KD can also assess difficulty reading or with screen use following a concussion.
Frontal Lobe Occipital Lobe Temporal Lobe	ImPACT Testing	5 and up	ImPACT (Immediate Post Concussion Assessment and Cognitive Testing) is an interactively administered computerized exam. This software program was developed by The University of Pittsburgh Medical Center's (UPMC) Sports Concussion program. It challenges the brain and tracks information such as memory, reaction time, processing speed, and concentration. A baseline, pre-injury ImPACT test is recommended every two years. If the athlete later suffers a brain injury, she/he can then retake this test. Any changes since the baseline test was taken may help determine the severity of the injury and the pace at which it is healing.
Cerebellum Occipital Lobe	Vestibular Ocular Motor Screening (VOMS)	10 and up	Ocular-Motor dysfunction occurs when muscles in the eye are not properly coordinated for eye movement. This dysfunction is common following concussion and can be a large contributing cause to visual disturbances during recovery and frequent headaches or symptoms. The VOMS can assess if ocular-motor dysfunction exists as well as issues with balance or vestibular issues. It is completed by a clinician or physician in both the baseline and post-concussion setting to help assist the clinical team in returning deficits back to normal prior to returning to the field. This issue can effect hand and eye coordination in sports as well as concentration and reading in school.
Frontal Lobe Cerebellum Brain Stem	Treadmill Testing	10 and up	Treadmill testing is a valuable tool for clinicians to determine physical function sooner after an injury. A child that becomes symptom free more quickly can be taken through a basic treadmill test to see if they are eligible for the Return to Play protocol to begin. This becomes especially important for children that do not have an ImPACT baseline to compare to or for children that struggle with successfully completing neuro-cognitive tests. Treadmill testing is also valuable in determining exercise tolerance as well as determining whether the body's response to exercise is normal when a child is still experiencing symptoms. Symptomatic treadmill testing is a significant help to our physical therapy team in determining an appropriate plan of care and gradual return to sports.



Concussion Management Common Tools

Subjective vs. Objective?

- **NONE CLAIM TO BE DIAGNOSTIC TOOLS**
- **FOR CONCUSSION**
- Neurocognitive Testing (ImPACT/ C3Logix)

What do all these have in common?



Cardiovascular Pillar - UPDATE

- Deconditioning the body post brain injury can slow recovery.
- Prolonged brain rest beyond 48 hours is controversial.

KEEP MOVING!!!!

New Research:.

- *BFR and Body Cooling for persistent PCS (initial stages of research)*
- *Interval Training*

NJ Legislature taking action
In 2010, the NJ state legislature developed a Concussion Law that was mandated in interscholastic sports programs to remove a student athlete that has a concussion from competition, practice, or return to play until they are evaluated and cleared by a physician that specializes in the evaluation and management of concussions.

Sneak peak at future legislation
In 2016, a Return to Learn Bill was passed by General Assembly in the State of New Jersey. If passed into law this could require in the future that a physician clearance is mandated to return to school, not just to return to play.

ROLES to Recovery

School
School Nurse
ATC
Coaches
Teacher
Guidance Counselor
Child Study

Parent and Student

Physician

Concussion Center
Fast track to Neurology/Neuropsychology, or neuro ophthalmology, when warranted
Assistance with Post-Concussive Testing/Evaluation
Assistance with Return to Learn/Activity (Symptom Log)
Co-management with pediatrician, school and family for Patient Navigation and safe progression and clearance.

Our multidisciplinary approach to concussion



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Name: _____

DOB: _____

Active Recovery Plan

Exercise Log: This daily at home exercise log is a tool that can help fast track your recovery for Return to Play (RTP). Please identify which cardiovascular activity (Walking, Treadmill, Stationary Bike) you participated in below each day. Please rate any symptoms you may have during your workout (1-2: Mild, 3-4: Moderate, 5-6: Severe) based on symptom key at the bottom of this page. **STOP ANYTIME YOUR SYMPTOMS CHANGE OR INCREASE.**

Activity: _____ Duration: _____ Times a day: _____ Additional comments: _____ _____	Borg Rating of Perceived Exertion 6 No exertion at all 7 8 Extremely light 9 Very Light 10 11 Light 12 13 Somewhat hard 14 15 Hard (heavy) 16 17 Very Hard 18 19 Extremely hard 20 Maximal exertion
---	---

1 Workout	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7
	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____
Activity							
Duration/Time							
RPE							
Symptoms							
2 Workout	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7
	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____
Activity							
Duration/Time							
RPE							
Symptoms							

Physical	Cognitive	Emotional	Sleep
(H)Headache, (N)Nausea, (V)Vomiting, (B)Balance Problems, (D) Dizziness, (VP)Visual Problems, (F)Fatigue, (SL)Sensitivity to light & (SN)Noise, (NT)Numbness/Tingling	(MF)Mentally Foggy,(SD)Slowed Down, (DC)Difficulty Concentrating, (DR)Difficulty Remembering	(I)Irritability, (S) Sadness, (NE)Nervousness, (E) Emotional (More than usual)	(DR) Drowsiness, (SLU)Sleeping Less Than Usual, (SMU)Sleeping More Than Usual, (TFA)Trouble Falling Asleep

****IF ATHLETE BEGINS TO VOMIT OR REPORTS AN INCREASED HEADACHE OR SYMPTOMS CONTINUE TO WORSEN, OR IF YOU HAVE ANY URGENT CONCERNS ABOUT THE ATHLETE’S CONDITION PLEASE REPORT TO THE CLOSEST EMERGENCY ROOM AND ALSO CALL THE MJM CENTER at 973-322-7913****

Athlete Signature: _____

Parent Signature: _____

Date : _____



Name: _____

Today's Date: _____

Patient Instructions: This daily symptom log is a tool that can be used to track your symptoms throughout recovery. Please identify (using the key below) & rate any symptom you have during your class (1-2: Mild, 3-4: Moderate, 5-6: Severe). Also include what activity (ie: reading, algebra, computer) that you were doing and how long it lasted

	EXAMPLE Class: <u>Math</u> Duration: <u>45</u> <u>minutes</u>	1 st Period Class: _____ Duration: _____	2 nd Period Class: _____ Duration: _____	3 rd Period Class: _____ Duration: _____	4 th Period Class: _____ Duration: _____	5 th Period Class: _____ Duration: _____	6 th Period Class: _____ Duration: _____	7 th Period Class: _____ Duration: _____	8 th Period Class: _____ Duration: _____
Cognitive work during class/ activity that caused symptoms	Smart Board use MacBook Use								
List Symptoms (using below abbreviations) during class & Rate (1-6)	H- 5 N-3 SL- 2								
How long did the symptom(s) last?	H- 2 hours N-30 minutes SL- 2 hours								
What did you do to reduce the symptom?	Left class 20 minutes early and rested at nurses office.								

Symptoms of a concussion:

Physical	Cognitive	Emotional	Sleep
(H)Headache, (N)Nausea, (V)Vomiting, (B)Balance Problems, (D) Dizziness, (VP)Visual Problems, (F)Fatigue, (SL)Sensitivity to light & (SN)Noise, (NT)Numbness/Tingling	(MF)Mentally Foggy,(SD)Slowed Down, (DC)Difficulty Concentrating, (DR)Difficulty Remembering	(I)Irritability, (S) Sadness, (NE)Nervousness, (E) Emotional (More than usual)	(DR) Drowsiness, (SLU)Sleeping Less Than Usual, (SMU)Sleeping More Than Usual, (TFA)Trouble Falling Asleep

Progress or Regress?

Progression Points

- Daily Check ins/
Symptom Inventories
- Communication with
Concussion Center or
Improvements /Lapses
- Active interventions
 - ✓ Basic Aerobic
 - ✓ Hand/Head/Eye
 - ✓ VOR retraining

Student:		Rehabilitation Program Log			
Course/Semester:		Graduate Athletic Training Education Program			
ATHLETE	DATE	SPORT	DIAGNOSIS and REHAB PHASE	Rehab Code	Rehab Program / Exercise / Sets and Reps
					ACI / CI Ints.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

Basic VOR progressions can be considered using appropriate metronome pace and based on symptomatology.



Return to Play – What's your RTP POC

- **Stage 1**
 - no symptoms (age dependent), 100% academia (48 hours full school and cognitive tasks within the asymptomatic week) ACTIVE RECOVERY (progress RTL/ Social)
- **Stage 2 (Recovery Zone)**
 - TM test \leq 70% HR, basic balance, oculomotor, sport movements
- **Stage 3 (Aerobic Zone)**
 - 80% HRR, sport movements, cone drills, cognitive dual tasking
- **Stage 4 (Anaerobic Zone)**
 - 90% + HRR, max effort, all sport specific tasks/High Intensity.
- **Stage 5**
 - Return to supervised sports
- **Stage 6**
 - Return to competition

Consider Antidepressant therapy, multiple concussion history. VOMS?

*****Vitals are a MUST!**

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- 1 Graduated return-to-sport (RTS) strategy**
Stage Aim Activity Goal of each step 1
Symptom-limited activity Daily activities that do not provoke symptoms Gradual reintroduction of work/school activities
- 2 Light aerobic exercise** Walking or stationary cycling at slow to medium pace. No resistance training Increase heart rate
- 3 Sport-specific exercise** Running or skating drills. No head impact activities Add movement
- 4 Non-contact training drills** Harder training drills, eg, passing drills. May start progressive resistance training Exercise, coordination and increased thinking
- 5 Full contact practice** Following medical clearance, participate in normal training activities Restore confidence and assess functional skills by coaching staff
- 6 Return to sport** Normal game play

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WHAT WE KNOW!

- Exercise is Medicine (Active Recovery works!)
- Rest is not best!
- Recovery plans must be prescriptive!
- The brain is 50% vision (Assess visual motor and visual tracking disturbances)
- Symptom severity can be a prognostic indicator for recovery.
- Early diagnosis, intervention and treatment drive improved patient outcomes
- Multiple concussion histories can delay recovery timelines
- Mental health effects and behavioral cognitive factors can present later with delayed onset of recovery and can impact length of recovery.



OCULAR MOTOR AND VESTIBULAR PILLAR

- Remember: The Vision system drives function
- ***The brain is 50% vision***
 - Primary complaints:
 - Head aches all day
 - Blurred vision
 - Double vision
 - Photophobia
 - Eye fatigue
 - Dizziness / Vertigo
 - #1 Trouble with Screens/ School/ Reading
 - Progress academics prescriptively

 - Headaches/Dizziness are two key symptoms most frequently reported upon initial injury that we are finding in studies (A high volume correlate with ocular motor dysfunction)



WHAT IS YOUR RECIPE FOR EFFECTIVE DIAGNOSIS?

2021 American Journal of Sports Medicine Study “Predictive Accuracy of Sports Concussion Assessment Tool Individually and in Combination”

- 419 Student athletes (Collegiate)

Modalities

- VOMS/ SCAT 3/ BESS

Conclusion

- *BESS lacked clinical significance determining concussion*
- *VOMS combined with SCAT produced 9% improvement in test sensitivity*

It is estimated by this study that an additional 304,000 athletes could be diagnosed annually with this combination of testing



How do we evolve?

Identify the driver that presents recovery delays and progress **EARLY!**

Clinical Journal of Sports Medicine 2017: “ Vision and Vestibular System Dysfunction Predicts Prolonged Concussion Recovery in Children.”

- 432 subjects (378 presented with visual/vestibular dysfunction)
OVER 87%!

Presentation consistently identified

- Balance with accommodation
- Symptom Provocation with VOR / Smooth pursuit

Conclusion – Above findings were associated with prolonged concussion recovery



VOMS

VESTIBULAR OCULAR MOTOR SCREENING

- Assessment to help determine neurological dysfunction
- Symptom score of 0-10
- Baseline scoring in the office completed just prior to administration of the VOMS and after each module is completed.
- Any change pre to post after completing the modules may indicate signs of concussion.
- 30 Reps VOR= 5 mins. reading

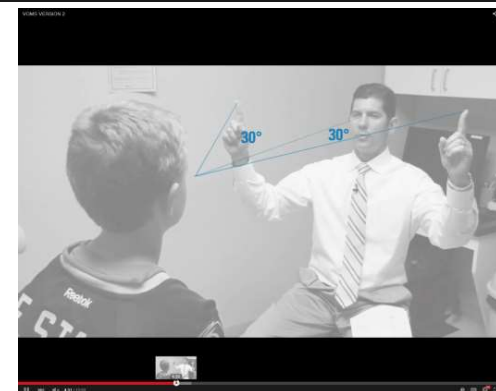
****Endorsed and validated by UPMC**

*****Validated for non-healthy controls and healthy controls**

VOMS VERSION 2

Press Esc to exit full screen mode.

Vestibular/Ocular Motor Test	Not Tested	Headache Rated 0-10	Dizziness Rated 0-10	Nausea Rated 0-10	Fogginess Rated 0-10	Comments
Baseline (Pre-VOMS) Symptoms						
Smooth Pursuits						
Saccades - Horizontal						
Saccades - Vertical						
Convergence (Near Point)						Near Point (cm):
VOR - Horizontal						
VOR - Vertical						
Visual Motor Sensitivity Test						



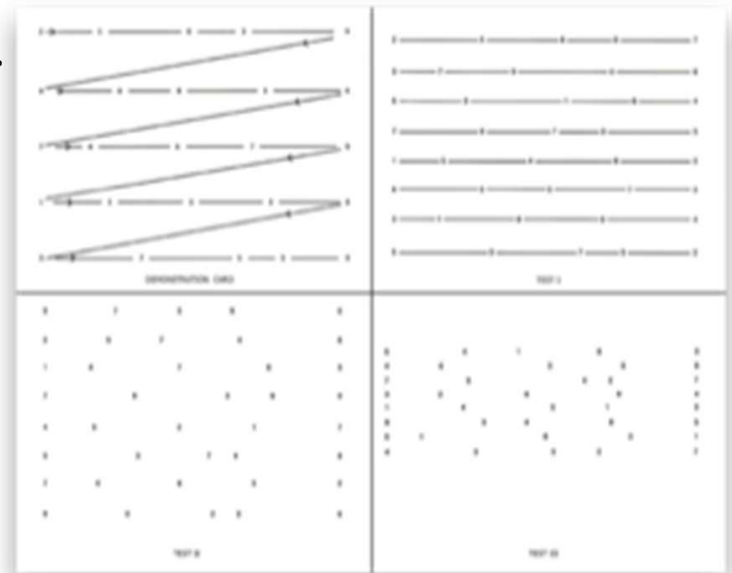
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Assessments at the Forefront: King Devick Test

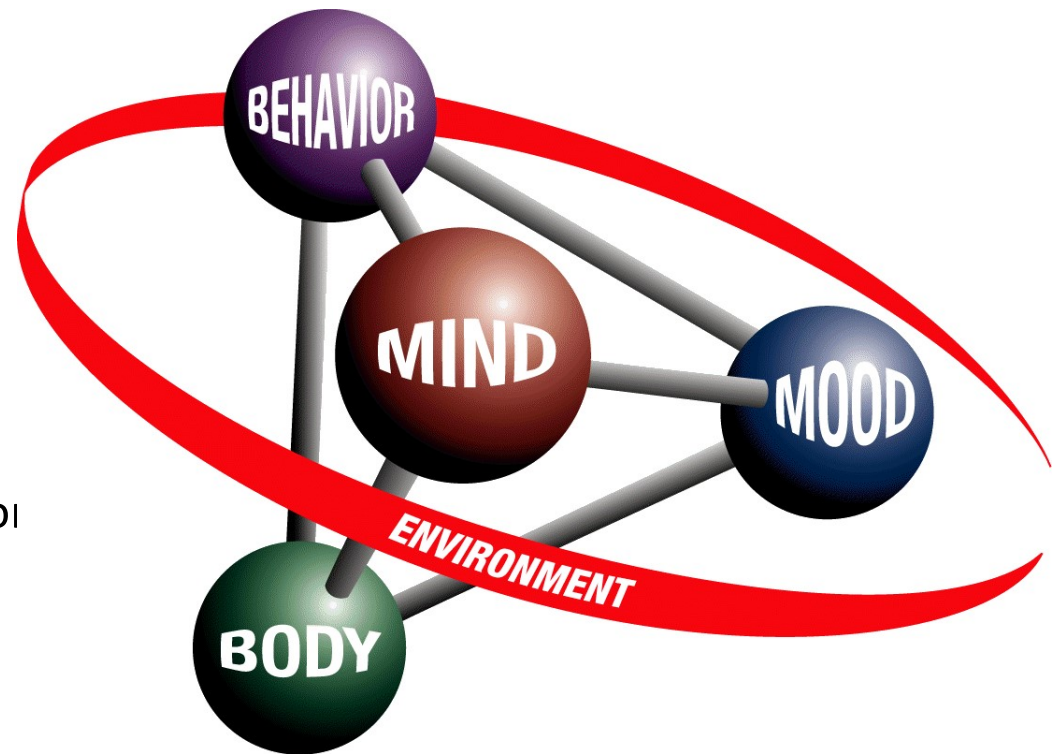
50% of the brain's pathways are tied to vision

- Sideline assessment or tool to assess suspicion of concussion. Recommended within the first 24 hours of impact.
- Measurement on the speed of rapid number naming.
 - *Timed test for reading single digit numbers on a card from left to right.*
- Evaluate eye movement, attention, and language to assess the baseline brain function, allowing the ability to predict worse outcomes in concussion.
- Baseline obtained; repeat testing done on sideline after injury to determine if a deficit exists at time of injury.
- Method of baseline for younger subjects
- Demo testing



Return to Learn before Return to Play

- Academic restrictions
- Graded activities
 - I.e. VOR > 30 reps = 5 minutes of reading.
- Cognitive Duel tasking
 - DURING ALL (PCS Rehab) tasks.
- Cognitive Therapy
 - If symptoms do not resolve within > 2 months PT
 - Or if stimulation/concentration is primary limiting factor.



RTL Before RTP- how do we gradually re-introduce?

****Parent and child/athlete **accountability**- Must have for effectiveness.



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Progressive Academia

- Gradual re-introduction of tasking through stimulation (smart board, mac book, phone use)
- No removal from school
- Reintroduce cognitive tasking immediately after 48 hours (Important for cognition, processing and social reintegration)
- **Morahan CAARP™**

Lower Symptom score- 50-75% cognitive load

Moderate- High symptom score- 20%-45% cognitive load

Asymptomatic post-concussion- minimum two full academic days off restriction prior to RTP stage 2.

- Advanced 504
 - Rare with patient compliance



Must be
prescriptive/individualized!



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SIDELINE ROLE

- *Effective and early identification*
- Provocation of symptoms
- Minimum VOMS/ SCAT combination for more effective measurables.
- Consider King-Devick on the sideline
- ***Identify ocular motor dysfunction and symptom presentation early on for more effective prognosis***

IS VOMS PART OF YOUR UNIVERSE?

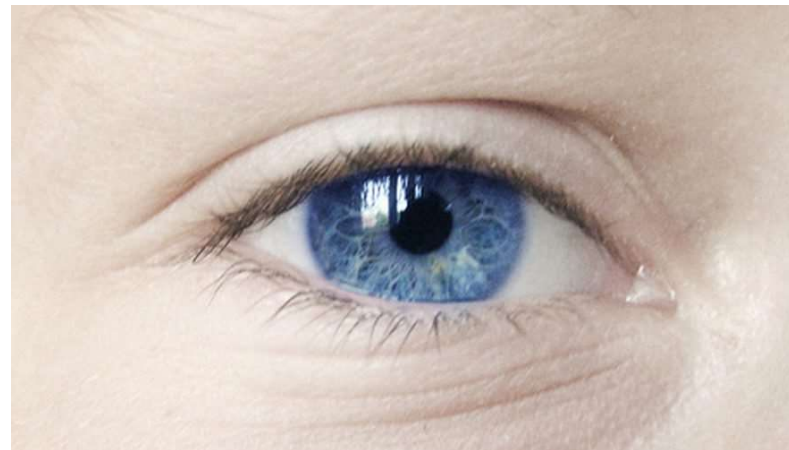


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Ocular Motor Pillar - UPDATE

- Vestibular Ocular Tasks
- Convergence exercises
- Eye strengthening



OBJECTIVE VISION ADVANCES

EYESYNC®

The EYE-SYNC technology is an Extended Reality (XR) based digital health platform utilized to assess brain health, deliver therapy, and optimize performance. It combines proprietary eye movement assessments with patient demographics, standardized digital inventories, and patient questionnaires to manage the comprehensive workflow of the clinician in a single, HIPAA compliant cloud based system.

Sensorimotor Variability: The Concussion Problem

In the over 15 years we have been pioneering research in the measurement of eye movements, we have found performance variability to be a key measure of human attention. Variance between eye-target position has been demonstrated as an indicator of real time cognitive function, and is commonly impaired after concussion. In a normal brain, attention is a by-product of moment to moment synchronization with predictive sensory input and task specific information, resulting in minimal performance variability.

The inability to efficiently synchronize with external cues increases variability in the sensorimotor system, and is believed to be a major cause of symptom exacerbation after concussion. High performance variability results in distractibility, decreased awareness, and reduced cognitive performance, each of which are highly prevalent after concussion injury.

Our Solution

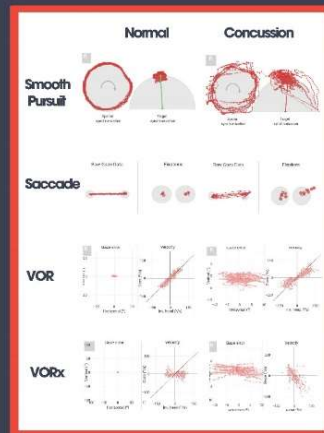
The FDA cleared EYE-SYNC technology creates value through:

- **Rapid Assessment**
Each test is 60 seconds in length
- **Objective & Quantifiable**
Unique data and metrics measure real time function
- **Accurate**
Precision measures indicate quality of data collected
- **Reliable**
0.9 Test-Retest Reliability
- **Easy to Use**
Any clinician/technician can learn
- **Mobile**
Access to patients anywhere

The Clinical Utility of Objective Eye Movements After Concussion Injury

In 2019, the first evidence based guidelines for concussion were published, *Concussion Guidelines Step 2: Evidence for Subtype Classification* (Brown, et al).

In these guidelines, ocular-motor and vestibular deficits after concussion are among the most prevalent dysfunctions in both pediatric and adult populations. By measuring for these impairments, diagnostic and therapeutic decisions can be supported with objective data.



How does EYESYNC® improve patient outcomes?

1) IDENTIFYING COGNITIVE IMPAIRMENTS *Supporting Clinical Decision Making*

Through a series of non-invasive eye movement assessments, impaired cognition can be objectively captured and identified as abnormal tracking, fixation, latency or gaze stability.

2) FACILITATING TARGETED TREATMENT *Confirming and Correcting Deficits*

By capturing robust objective data, it becomes easier to clearly identify dysfunction and rule out normal results as a source of symptoms. This helps to formulate the basis of a specific treatment plan.

3) MONITORING IMPROVEMENT FROM THERAPY *Validating Effectiveness of Interventions*

In follow up visits, clinicians can utilize objective data to determine the dose response and subsequent rate of improvement from the chosen therapy. This can be employed at a single time point, or through serial monitoring efforts, where the long term impact of targeted therapies can be more thoroughly evaluated.

Contact US

If you are interested in learning more about EYE-SYNC or want to arrange for a video demonstration, please contact us at the following:

email: sales@syncthink.com
phone: 650.727.1819



The digital workflow for the concussion provider:

Patient Information:

- Demographics
- Family History
- Medical History
- Academic History
- Sports Information

Eye Movement Assessment:

- Smooth Pursuit
- Saccade
- Near Point of Convergence (NPC)*
- Vestibulo-ocular Reflex (VOR)
- VOR Cancellation (VORx)

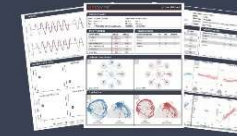
Standardized Inventories:

- SCAT5
- BESS
- Simple Reaction Time (SRT)
- Concussion Incident Reporting

Patient Questionnaires:

- BSI-18
- PHQ9

EYESYNC®
Next Gen Neurotechnology



**60 seconds is
all it takes**

Discover how SyncThink's mobile technology, EYE-SYNC, can rapidly assess impairments and quantify deficits after concussion. Using proprietary eye tracking measurements and analysis, clinicians can better understand the type and severity of dysfunction, the response to therapies, and chart improvement over time.

After each 60 second assessment, a customizable, multi-page report generates, providing new and actionable insights in order to guide better clinical decision making and improve patient outcomes.

To learn more go to syncthink.com

EYESYNC®
Concussion
Management
Technology

Measure What Matters.



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EYE SYNC TECHNOLOGY VALIDATED

What is EYE-SYNC?

Syncthink 3

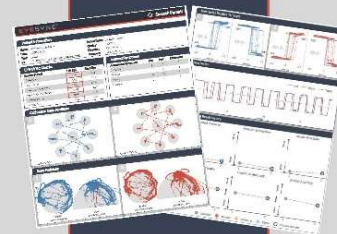
The EYE-SYNC technology is an Extended Reality (XR) based digital health platform designed to manage the spectrum of brain health and performance. Utilizing the latest advances in mobile, wireless hardware EYE-SYNC creates a centralized data management system to support clinical decision making, from diagnosis through treatment.

7 Eye Tracking Assessments	60 Seconds Per Test	<ul style="list-style-type: none"> Smooth Pursuit Saccade 	<ul style="list-style-type: none"> VOR VOR Cancellation 	120 Data Points Collected
16 Neurocognitive Assessments	5 Minutes or Less	<ul style="list-style-type: none"> Balance Cognitive Function 	<ul style="list-style-type: none"> Working Memory Reaction Time 	15 Types of Patient Diagnosis
10 Patient Inventories & Questionnaires	90 Seconds to Complete	<ul style="list-style-type: none"> Depression/Anxiety Symptoms 	<ul style="list-style-type: none"> ADHD Sleep 	12 Types of Diagnostic Workflows
6 Dynamic Visual Training Paradigms	100 Percent Customizable	<ul style="list-style-type: none"> Tracking Fixation 	<ul style="list-style-type: none"> Gaze Stability Visual Integration 	10 Variations Per Paradigm

Eye Tracking Analysis and Reporting

Syncthink 7

EYESYNC® Standard Reports



Detailed metrics, induced symptoms and customizable visuals compare results over time of each eye captured

SYNCTHINK® Advanced Reports



Includes percentile rank as a distinct comparison to normative data derived from the SyncThink database

SYNCTHINK® Advanced Report Summary



Consolidated findings that highlight only abnormal results, includes space for clinician input of impression and recommendations

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



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Advances and Considerations in Brain Injury Management

Research Focuses

- Measurable Sub-concussive Blows and Neurological Impairment
- Brain activity pre and post concussion
- Blood Biomarker Trends
- Objective and validated visual assessments
- Re-training Autonomic dysfunction and VO impairment with more variability
- Enhanced Diagnostic capabilities

How do we differentiate between symptom resolution and neurological impairment?



CONCUSSION TECH PRACTICALITY

How to identify practical technology ?

Journal of Concussion 2021: “Technology and Concussion a Scoping Review.”

- 29 publications
- Common themes
 - ✓ Visual/Motor
 - ✓ Neurocognitive
 - ✓ Balance/Dual tasking



Conclusions

- Need more accurate validated technology
- Technology was helpful in identifying symptoms/ deficits some with higher specificity than others but none diagnostic.
- Neurocognitive testing had questionable sensitivity/ specificity
- App log for symptoms effective only with clinical monitoring
- IPAD visualization testing offered little evidence on differentiation for concussion



Subconcussive Blows

Challenges

- Chronic impairment effects
- Difficulty quantifying the relevance of the change
- Longitudinal studies and funding
- Limited population studies
- Technology restrictions (functional MRI)
- *“The functional outcomes, duration, and consequences of imaging changes related to subconcussive head impacts are not well understood.”*

How do we advance

- Study varying populations
- Quantifying impairments in practical medicine and learning how to treat those impairments or identify early on before they become progressive.



Subconcussive blows

2019 Brain

“Brain Vital Signs detect concussion-related neuropsychological impairments in ice hockey”

- 47 Junior Ice Hockey players; 43 completed baseline EEG
- Some with previous concussion and some without
- Ages 16-18

Conclusion

- *Neuropsychological impairments persisted after **observable** clinical signs and symptoms subsided*
- *Shown impairment in EEG studies consistent with brain vitals and amplitudes after symptom resolution*
- *Currently nothing to objectively measure subconcussive impairment.*



In Conclusion

Advancing Brain Injury Medicine

- Functional disturbances may exist in athletes that have suffered SRC.
- Considerations of neuropsychological impairment can exist beyond symptom resolve.
- Quantifying the cumulative effects of functional damage over time from sub- concussive blows is still not well understood however advances in technology protocols are being studied.
- Advanced imaging still has limitations in studying changes in patients post concussion due to financial and participant
- Quicker diagnosis and intervention with a multidisciplinary concussion team will lead to stronger prognosis and improved patient outcomes.
- Earlier intervention of exercise based methods that are innovative as well as daily symptom check ins can improve patient outcomes and recovery.



In Conclusion

Advancing Brain Injury Medicine in Practice

- Quicker diagnosis and intervention with a multidisciplinary concussion team will lead to stronger prognosis and improved patient outcomes.
- Earlier intervention of exercise based methods that are innovative as well as daily symptom check ins can improve patient outcomes and recovery.
- **Choose the right tools that are practical and effective for your evaluation and management!**
- **Track and progress and keep communication lines open with the concussion center/ provider for more aggressive outcomes.**



Thank you!



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