Concussion Management

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Why Do we do this?

Disclosures

MCMI
ImPACT

MCMI
Mission statement

The Mission of MCMI is to improve the safety of Maine's youth by reducing activity related concussions.

Our Goals

Provide Consistent Concussion Management through:

- Standardizing return-to-play guidelines
- Increasing education about concussion in sports
- Establishing a network of Maine professionals trained in concussion management
- Offering computerized neurocognitive testing (ImPACT) to assist with concussion evaluation

MAINE CONCUSSION MANAGEMENT INITIATIVE

Workshop Goals

- Update on Concussion Definition
- Review LD 1873
- Introduce what is new from Zurich 2013
- Concussion Assessment Tools
  - Postural Sway Assessment- SWAY™ Balance App
  - Saccade Eye Movement- King-Devick™
  - Visual Ocular Motor Testing- VOMS
  - Balance Assessment- BESS Test
  - Neurocognitve Testing- ImPACT™ testing
- Conclusion

MAINE CONCUSSION MANAGEMENT INITIATIVE

Concussion: Historical
JAMA 1928 Martland et al

- For some time fight fans and promoters have recognized a peculiar condition occurring among prize fighters which, in ring parlance, they speak of as "punch drunk." Fighters in whom the early symptoms are well recognized are said by the fans to be "cuckoo," "goofy," "cutting paper dolls," or "slug nutty."

- Punch drunk most often affects fighters of the slugging type, who are usually poor boxers and who take considerable head punishment, seeking only to land a knockout blow. It is also common in second rate fighters used for training purposes, who may be knocked down several times a day. Frequently it takes a fighter from one to two hours to recover from a severe blow to the head or jaw. In some cases consciousness may be lost for a considerable period of time.

Concussion: Historical
(American Academy of Neurology, 1997)

"Any alteration of mental function following a blow to the head that may or may not involve a loss of consciousness."

American Academy of Neurology, 1997

Concussion: Historical (Vienna 2001)

"… a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces…."

Concussion in Sport Group, Vienna-2001

Concussion Definition (Zurich, 2012)

"Concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces."

MAINE CONCUSSION MANAGEMENT INITIATIVE

Concussion Definition (Zurich, 2012)

DIREC BLOW- head, face, neck or '**impulsive'** force transmitted to the head

RAPID ONSET of SHORT LIVED impairment of neurological functions that resolve spontaneously

- Signs and symptoms may evolve over a number of minutes to hours
- A graded set of clinical symptoms which may or may not result in loss of consciousness
- Resolution of clinical and cognitive symptoms usually in a sequential course
- Symptoms may be prolonged in some cases

NEUROPATHALOGICAL CHANGES:

- functional disturbance rather than a structural injury normal imaging

But What does this all mean?

- How do we fit this into our clinical context of seeing patients?

High School Basketball Player

- Basketball player had head to head contact with opposing player. Came out after half time complaining of head ache, sensitivity to light/noise, memory problems, nausea.
- Pt. was assessed by the Athletic Trainer and she determined that the student had a concussion. Parents were notified about the injury.
- Pt was out of school for almost a week. Returned to school without a complete resolution of symptoms and then cleared to resume Basketball at 2 weeks by ATC.
- Pt. has had no baseline ImPact tests but the ATC administered 2 post injury ImPact tests.
- Patient comes into your office because her parents are worried failing in school- prior A student now failing 3 classes and to ask about her risk for another concussion.

Does this case meet the requirements of LD 1873?

- All parents/students educated on concussion yearly
- All administrative staff that work directly with students educated o concussion
- All Coaching staff educated on concussion
- All students sustaining head injury must be evaluated for concussion by HC provider trained in concussion management
- All students diagnosed with concussion must be removed from play and may not return that day
- All students must be cleared by a medical provider trained in concussion management before cleared for GRTA
- All students must pass Graduated Return to Activity before they may return to athletics

What about Zurich 2013 Consensus statement on Concussions?

- ? SAME DAY RETURN TO PLAY
- BESS/Balance TESTING
- Treatment strategies
- Exercise/ activity
- SCAT 3

- * PDF available for review on your own

McCrory P, Meeuwisse WH, Aubry M, et al. Br J Sports Med 2013; 47:250–258

MAINE CONCUSSION MANAGEMENT INITIATIVE

Zurich 2013:Same day return to play?

- NO!
- Unanimously agreed that no RTP should occur on the day of concussive injury

Zurich 2013:Management

- CORNERSTONE = initial period of <u>rest until acute symptoms resolve</u>
  - Physical Rest
    - No training, playing, exercise, weights
    - Beware of exertion with activities of daily living
  - Cognitive Rest
    - No television, extensive reading, video games?
    - Caution re: daytime sleep

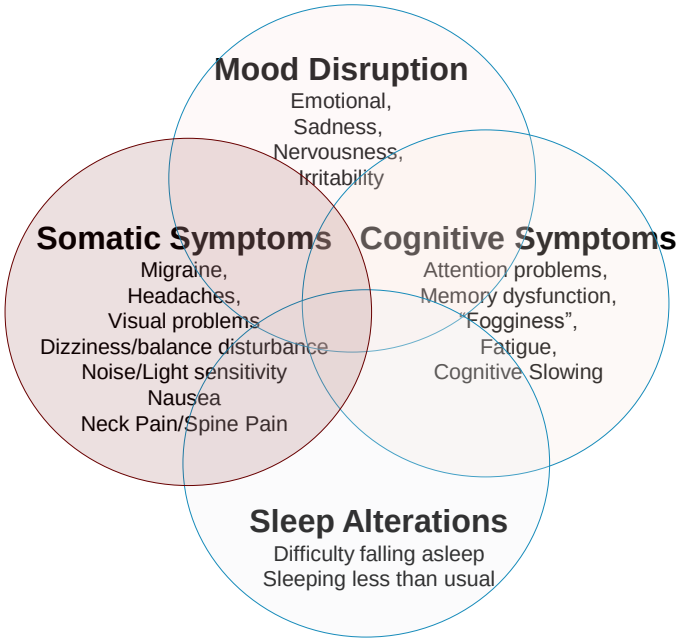
Zurich 2013: Balance testing

- Postural stability testing-deficits 72hr post concussion-Acute Effects and Recovery time following Concussion in Collegiate Football Players (The NCAA Concussion Study)McRea et al:: JAMA, November 19, 2003-Vol 290,No. 19
  - Balance Findings- Immediate BESS score higher than controls
  - Balance returned normal by 3-5 days post concussion
- Multiple studies have shown balance is affected by concussion-Balance error scoring system (BESS), force plate technology
- Valuable ONLY if baseline data available
- Time intensive
- Learned effect in older athletes
- Results affected by many factors (fatigue, illness, etc.)

Zurich 2013:PCS Assessment/Referral

PHQ-9? GAD-7/ Pediatric Symptom Checklist
Psychotherapy
Psychology
Psychiatry
Primary Care Provider
Social Work

Headache Log
Vestibular Therapy
Physical Therapy
Relaxation techniques
Guided Imagery
Integrative Medicine Clinic
Neurology
Ophthalmology



ImPACT Testing
Pediatric Symptom Checklist
Vanderbilt ADHD Scale
Driving Evaluation
Speech Therapy
Occupational Therapy
Psychology
Psychiatry
Neuropsychology

Sleep Log
Sleep Specialist

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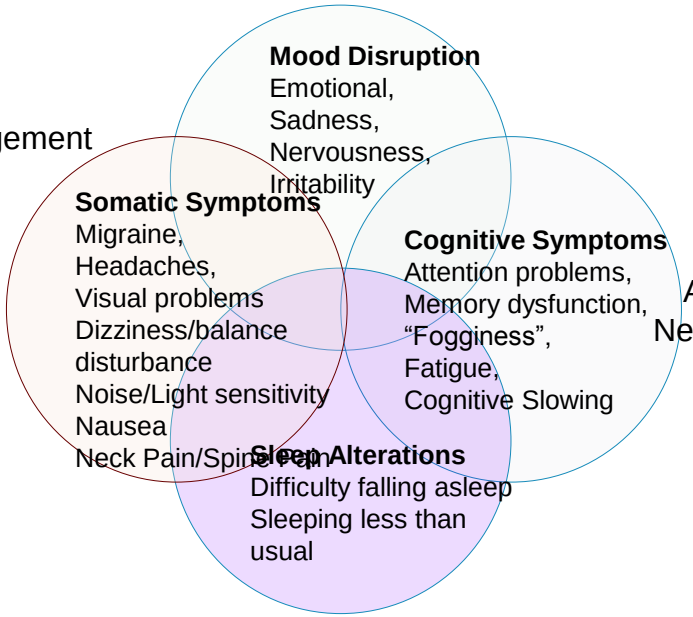
MAINE CONCUSSION MANAGEMENT INITIATIVE

Zurich 2013:PCS Management

Antidepressants
Anxiolytics
Psychotherapy

Non-Pharm Headache Management
OTC: NSAIDs
Triptans
Beta Blockers
CCB
Antiepileptics
Antidepressants
Flexeril
Valium
Amitriptyline



Amantadine* (off label)
Neurostimulants* (off label)

Behavioral: Sleep hygiene education, relaxation therapies, sleep schedule
Pharmacologic: melatonin, amitriptyline, trazadone, short-term use of nonbenzodiazepines

SCAT-3

- Offers a standardized method of evaluating athletes aged 13 years and older for concussion.
- Is a component of the 2013 Zurich Consensus Statement on Sport Concussion.
- Is a screening evaluation tool designed for use only by qualified first responders or medical professionals
- Does not independently determine the diagnosis of a concussion, nor does it independently determine the injured athlete’ s recovery or return to play status.

SCAT 3

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SCAT 3

any of these problems?

Are you on any medications? if yes, please list: ☐ Y ☐ n

SCAT3 to be done in resting state. Best done 10 or more minutes post excercise.

Sym PTo m evAl u ATio n

3 how do you feel?

"You should score yourself on the following symptoms, based on how you feel now".

	none	mild		moderate		severe	
Headache	0	1	2	3	4	5	6
"pressure in head"	0	1	2	3	4	5	6
neck pain	0	1	2	3	4	5	6
nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
trouble falling asleep	0	1	2	3	4	5	6
more emotional	0	1	2	3	4	5	6
irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6

carpet	0	1	0	1	0	1	sugar	perfume	blanket
saddle	0	1	0	1	0	1	sandwich	sunset	lemon
bubble	0	1	0	1	0	1	wagon	iron	insect
Total									

immediate memory score total ____ of 15

Concentration: digits Backward

List	Trial 1		Alternative digit list		
4-9-3	0	1	6-2-9	5-2-6	4-1-5
3-8-1-4	0	1	3-2-7-9	1-7-9-5	4-9-6-8
6-2-9-7-1	0	1	1-5-2-8-6	3-8-5-2-7	6-1-8-4-3
7-1-8-4-6-2	0	1	5-3-9-1-4-8	8-3-1-9-6-4	7-2-4-8-5-6
Total of 4					

Concentration: month in reverse order (1 pt. for entire sequence correct)

Dec-nov-oct-Sept-Aug-Jul-Jun-may-Apr-mar-Feb-Jan ☐ 0 ☐ 1

Concentration score ____ of 5

5 neck examination:

range of motion tenderness upper and lower limb sensation & strength

Findings: _____

6 Balance examination

Do one or both of the following tests.

Footwear (shoes, barefoot, braces, tape, etc.) _____

Modified Balance Error Scoring System (BESS) testing[5]

Which foot was tested (i.e. which is the **non-dominant** foot) ☐ left ☐ right

Testing surface (hard floor, field, etc.) _____

Condition

SCAT 3

any order, even if you said the word before."

Complete all 3 trials regardless of score on trial 1 & 2. Read the words at a rate of one per second. **Score 1 pt. for each correct response.** Total score equals sum across all 3 trials. Do not inform the athlete that delayed recall will be tested.

Concentration

digits backward

"I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7."

If correct, go to next string length. If incorrect, read trial 2. **One point possible for each string length.** Stop after incorrect on both trials. The digits should be read at the rate of one per second.

months in reverse order

"Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November … Go ahead"

1 pt. for entire sequence correct

delayed recall

the delayed recall should be performed after completion of the Balance and Coordination examination.

"Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order."

Score 1 pt. for each correct response

Balance examination

Modified Balance Error Scoring System (BESS) testing[5]

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)[5]. A stopwatch or watch with a second hand is required for this testing.

"I am now going to test your balance. Please take your shoes off, roll up your pant legs above ankle (if applicable), and remove any ankle taping (if applicable). This test will consist of three twenty second tests with different stances."

(a) double leg stance:

"The first stance is standing with your feet together with your hands on your hips and with *your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes."*

Tandem gait[6]:

Participants are instructed to stand with their feet together behind a starting line (the test is best done with footwear removed). Then, they walk in a forward direction as quickly and as accurately as possible along a 38mm wide (sports tape), 3 meter line with an alternate foot heel-to-toe gait ensuring that they approximate their heel and toe on each step. Once they cross the end of the 3m line, they turn 180 degrees and return to the starting point using the same gait. A total of 4 trials are done and the best time is retained. Athletes should complete the test in 14 seconds. Athletes fail the test if they step off the line, have a separation between *their heel and toe, or if they touch or grab the examiner or an object. In this case, the time is not recorded and the trial repeated, if appropriate.*

Coordination examination

upper limb coordination

Finger-to-nose (FTN) task:

"I am going to test your coordination now. Please sit comfortably on the chair with your eyes open and your arm (either right or left) outstretched (shoulder flexed to 90 degrees and elbow and fingers extended), pointing in front of you. When I give a start signal, I would like you to perform five successive finger to nose repetitions using your index finger to touch the tip of *the nose, and then return to the starting position, as quickly and as accurately as possible."*

Scoring: 5 correct repetitions in < 4 seconds = 1
Note for testers: Athletes fail the test if they do not touch their nose, do not fully extend their elbow or do not perform five repetitions. **Failure should be scored as 0.**

references & Footnotes

1. this tool has been developed by a group of international experts at the 4th international Consensus meeting on Concussion in Sport held in Zurich, Switzerland in november 2012. the full details of the conference outcomes and the authors of the tool are published in the BJSm injury prevention and Health protection, 2013, Volume 47, issue 5. the outcome paper will also be simultaneously co-published in other leading biomedical journals with the copyright held by the Concussion in Sport Group, to allow unrestricted distribution, providing no alterations are made.

2. mcCrory p et al., Consensus Statement on Concussion in Sport – the 3rd international Conference on Concussion in Sport held in Zurich, november 2008. British Journal of Sports medicine 2009; 43: i76-89.

3. maddocks, DI ; Dicker, GD; Saling, mm. the assessment of orientation following concussion in athletes. Clinical Journal of Sport Medicine. 1995; 5(1): 32–3.

4. mcCrea m. Standardized mental status testing of acute concussion. Clinical Journal of Sport medicine. 2001; 11: 176–181.

SCAT 3

r eturn to play

Athletes should not be returned to play the same day of injury.
When returning athletes to play, they should be **medically cleared and then follow a stepwise supervised program,** with stages of progression.

For example:

r ehabilitation stage	Functional exercise at each stage of rehabilitation	o bjective of each stage
n o activity	physical and cognitive rest	r ecovery
l ight aerobic exercise	Walking, swimming or stationary cycling keeping intensity, 70 % maximum predicted heart rate. n o resistance training	increase heart rate
Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. n o head impact activities	Add movement
n on-contact training drills	progression to more complex training drills, eg passing drills in football and ice hockey. may start progressive resistance training	exercise, coordination, and cognitive load
Full contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
r eturn to play	n ormal game play	

There should be at least 24 hours (or longer) for each stage and if symptoms recur the athlete should rest until they resolve once again and then resume the program at the previous asymptomatic stage. r esistance training should only be added in the later stages.

if the athlete is symptomatic for more than 10 days, then consultation by a medical practitioner who is expert in the management of concussion, is recommended.

medical clearance should be given before return to play.

n otes:

Co n Cu SSio n injur y Adv iCe

(To be given to the **person monitoring** the concussed athlete)

t his patient has received an injury to the head. A careful medical examination has

patient's name _____

Date/time of injury _____

Date/time of medical review _____

SCAT3 - Key Differences

- SCAT3 – Adult (13 years +) and Child Versions (<13 years old).
  SCAT3 – Adult – maintains many features of SCAT2.
  - Adds Visible Signs of Concussions.
  - Indications for Emergency Management.
  - Balance Examination includes Tandem Gait.
- No longer uses a total score, although subsections can be scored.
- SCAT3 is a screening tool and not a substitute for formal neuropsychological testing.
- SCAT3 – Child – Developmentally appropriate for children younger than 13.

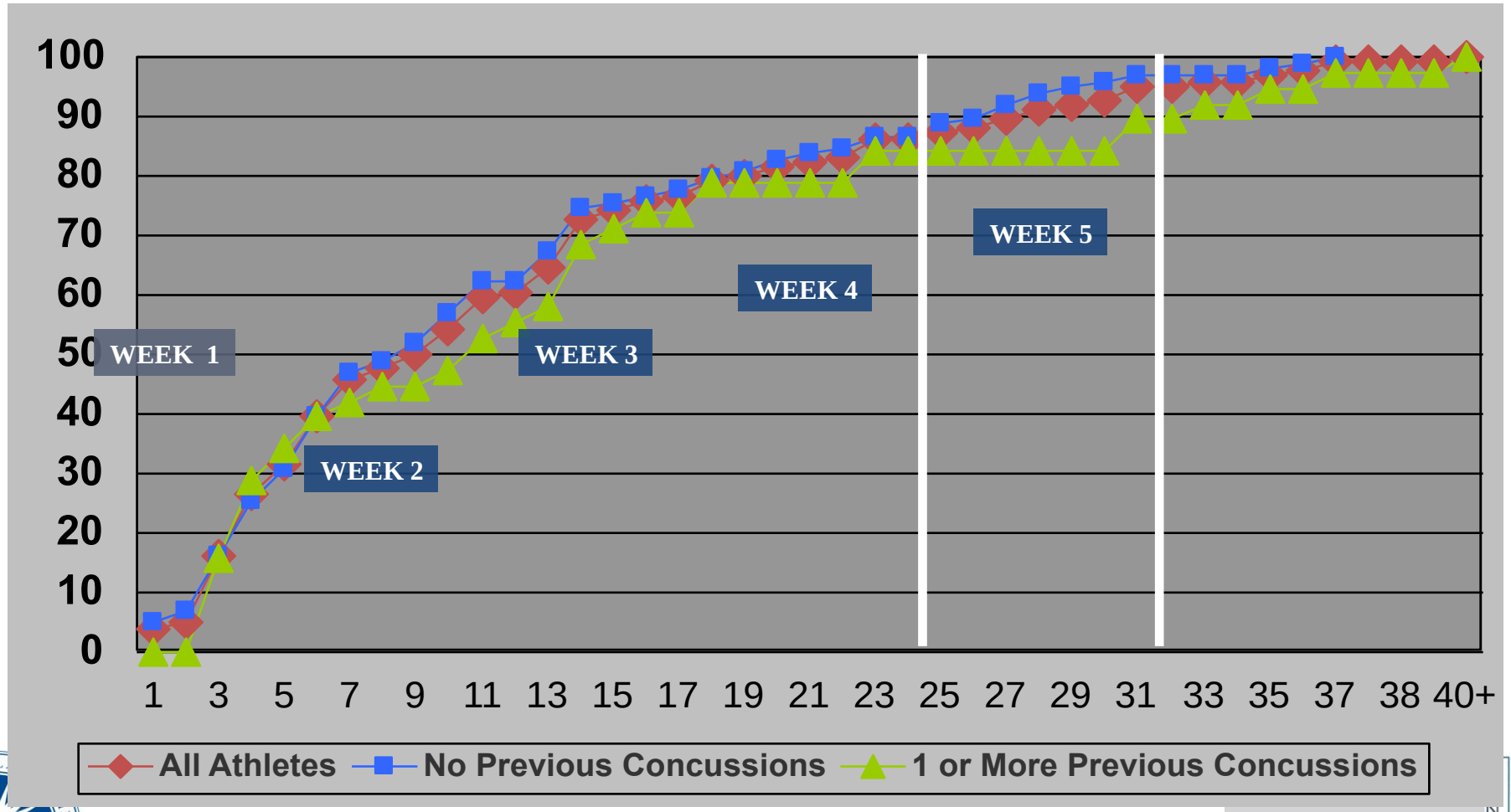
High School Basketball Player

- Basketball player had head to head contact with opposing player. Came out after half time complaining of head ache, sensitivity to light/noise, memory problems, nausea. Removed from play with clear s/s of concussion
- Pt. was assessed by the Athletic Trainer and she determined that the student had a concussion. Parents were notified about the injury. Is an ATC able to make the diagnosis of concussion?
- Pt was out of school for almost a week. Returned to school without a complete resolution of symptoms and then cleared to resume Basketball at 2 weeks by ATC. Were here symptoms resolved before RTP and did she pass GRTA
- Pt. has had no baseline ImPact tests but the ATC administered 2 post injury ImPact tests. Are ATC's able to review PI tests without consultation with HC provider?
- Patient comes into your office because her parents are worried failing in school- prior A student now failing 3 classes and to ask about her risk for another concussion. Has the patient recovered from her concussion? Which begs the prior question.

What additional information do you want to know about the patient?

ADHD	No
LD	No
Migraine/Headache	Yes-+ HA treatment
Concussion History	First Concussion
Motion Sickness	No
Repeat year of school	No

Recovery from Concussion: How Long Does it Take?



N=134 High School athletes

Collins et al., 2006, Neurosurgery

When you meet with them the parents give you her ImPact Tests

ImPACT™ Clinical Report

Basketball Ryan (header)

Basketball Ryan

Organization:	Bangor High School		
Subject ID#:	Test ID		
Date of Birth:	01/01/1993	**Age:**	17
Gender:	Female	**Height:**	73 inches
Handedness:	Right	**Weight:**	
Native country/region:	United States	**Second language:**	
Native language:	English	**Years Speaking:**	
Years of education completed excluding kinder garden:	9	**Repeated one or more years of school:**	No
Received speech therapy:	No	**Diagnosed learning disability:**	No
Attended special education classes:	No	**Problems with ADD/hyperactivity:**	No
Current sport:	Basketball	**Current level of participation:**	High School
Primary position/event/class:	Post	**Years of experience at this level:**	1

Number of times diagnosed with a concussion (excluding current injury):	1
Concussions that resulted in loss of consciousness:	0
Concussions that resulted in confusion:	1
Concussions that resulted in difficulty remembering events that occurred immediately after injury:	1
Concussions that resulted in difficulty remembering events that occurred:	0
Total games missed as a result of all concussions combined:	0
Concussion history:	February/2010

Treatment for headaches by physician:	Yes	**History of meningitis:**	No
Treatment for migraine headaches by physician:	No	**Treatment for substance/alcohol abuse:**	No
Treatment for epilepsy/seizures:	No	**Treatment for psychiatric condition (depression, anxiety):**	No
History of brain surgery:	No		

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MAINE CONCUSSION MANAGEMENT INITIATIVE

ImPACT™ Clinical Report

Basketball Ryan

Exam Type	Post-Injury 1	Post-Injury 2			
Date Tested	02/11/2010	02/16/2010			
Last Concussion	02/02/2010	02/02/2010			
Exam Language	English	English			
Test Version	2.0	2.0			

Composite Scores						
Memory composite (verbal)	57	<1%	59	<1%		
Memory composite (visual)	63	21%	54	13%		
Vis. motor speed composite	31.03	8%	35.17	25%		
Reaction time composite	0.58	39%	0.61	25%		
Impulse control composite	11		5			
Total Symptom Score	24		10			

Percentile scores if available are listed in small type.

Hours slept last night	7	8			
Medication					

Word Memory					
Hits (Immediate)	6	6			
Correct distractors (immed.)	10	9			
Learning percent correct	67%	63%			
Hits (delay)	5	6			
Correct distractors (delay)	7	4			
Delayed memory pct. correct	50%	42%			
Total percent correct	58.5%	52.5%			

Design Memory					
Hits (Immediate)	9	10			
Correct distractors (immed.)	11	9			
Learning percent correct	83%	79%			
Hits (delay)	9	6			
Correct distractors (delay)	7	7			
Delayed memory pct. correct	67%	54%			
Total percent correct	75%	66.5%			

X's and O's					
Total correct (memory)	6	5			
Total correct (interference)	109	111			
Avg. correct RT (interfer.)	0.52	0.52			
Total incorrect (interference)	9	5			
Avg. incorrect RT (interfer.)	0.38	0.37			

Symbol Match					
Total correct (visible)	26	27			
Avg. correct RT (visible)	1.32	1.68			
Total correct (hidden)	6	4			
Avg. correct RT (hidden)	1.31	1.87			

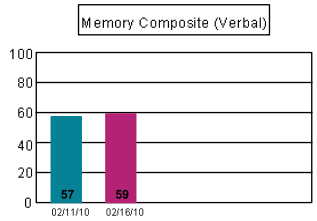
Color Match					
Total correct	8	9			
Avg. correct RT	0.79	0.75			
Total commissions	2	0			
Avg. commissions RT	0.83	0			

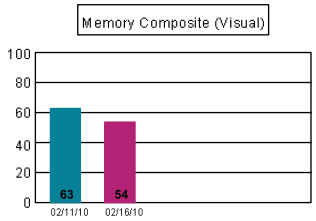
Three Letters					
Total sequence correct	2	3			
Total letters correct	7	12			
Pct. of total letters correct	46.67%	80%			
Avg. time to first click	2.36	2.37			
Avg. counted	12.4	14.2			
Avg. counted correctly	11.6	14.2			

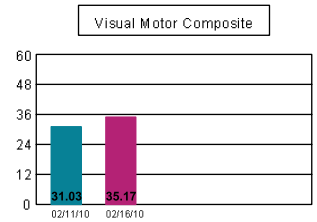
ImPACT™ Clinical Report

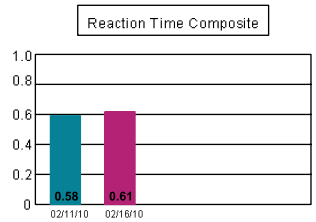
Basketball Ryan

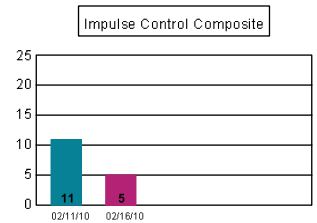
Headache	4	1			
Nausea	1	0			
Vomiting	0	0			
Balance Problems	1	0			
Dizziness	1	0			
Fatigue	2	0			
Trouble falling asleep	3	2			
Sleeping more than usual	0	0			
Sleeping less than usual	2	0			
Drowsiness	1	0			
Sensitivity to light	1	0			
Sensitivity to noise	3	2			
Irritability	1	0			
Sadness	0	0			
Nervousness	0	0			
Feeling more emotional	0	0			
Numbness or tingling	0	0			
Feeling slowed down	0	0			
Feeling mentally foggy	0	1			
Difficulty concentrating	3	2			
Difficulty remembering	1	2			
Visual problems	0	0			
Total Symptom Score	**24**	**10**			

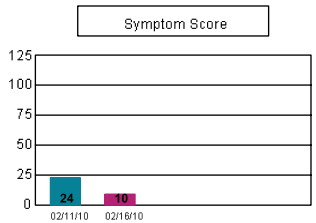

Memory Composite (Verbal)
100
80
60
40
20
0
57
59
02/11/10
02/16/10


Memory Composite (Visual)
100
80
60
40
20
0
63
54
02/11/10
02/16/10


Visual Motor Composite
60
48
36
24
12
0
31.03
35.17
02/11/10
02/16/10


Reaction Time Composite
1.0
0.8
0.6
0.4
0.2
0
0.58
0.61
02/11/10
02/16/10


Impulse Control Composite
25
20
15
10
5
0
11
5
02/11/10
02/16/10


Symptom Score
125
100
75
50
25
0
24
10
02/11/10
02/16/10

What Does her ImPact test Show?

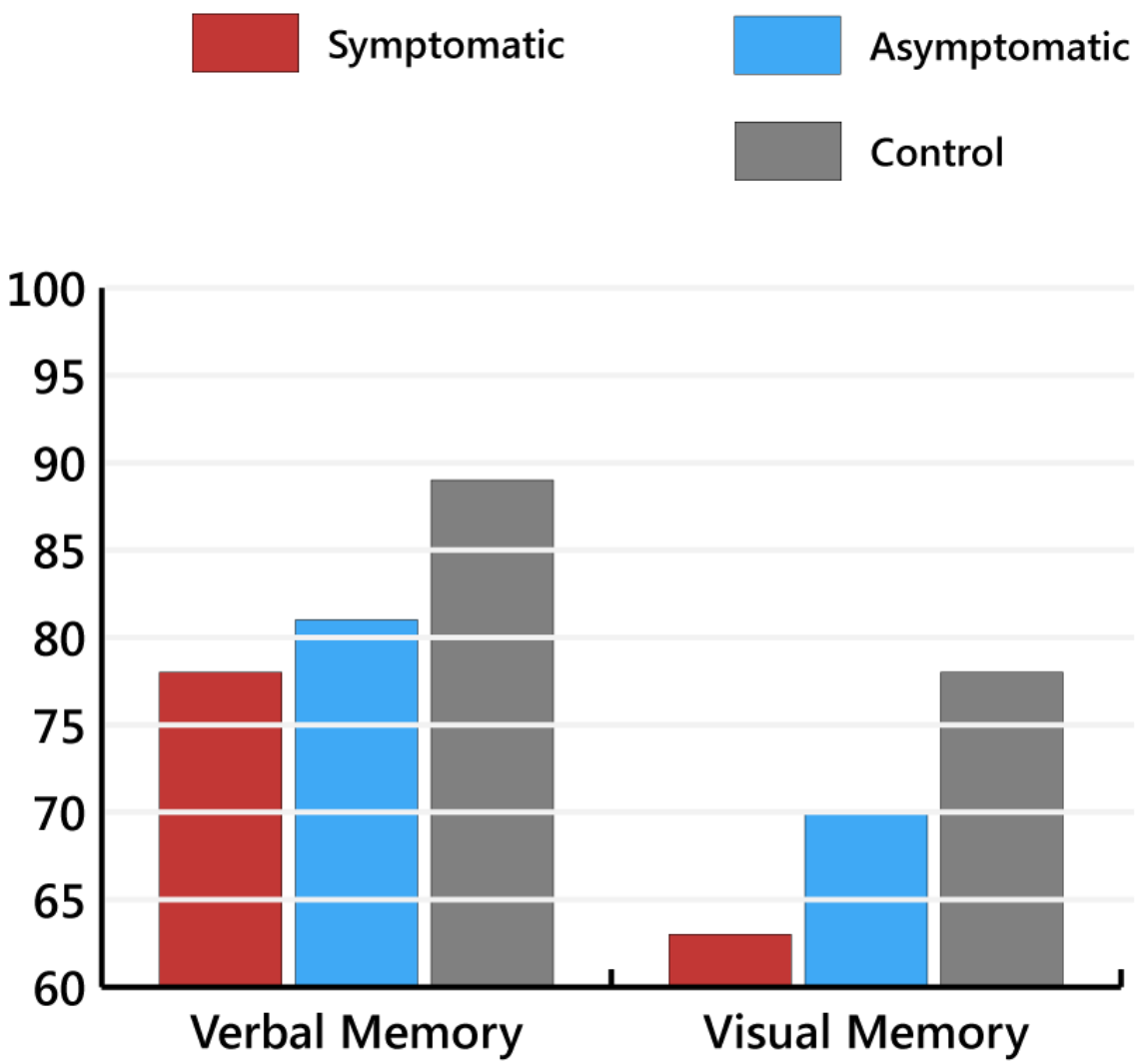
- No Baseline
- S/S- 24 then 10
- All 4 composite low for a former A student
  - Verbal <1 %
  - Visual 13%

How Neuropsych testing can help?

- Baseline testing
- Normative data
- Reliable change data without a baseline
- Concrete information for patients/parents to objectively measure changes in cognition

MAINE CONCUSSION MANAGEMENT INITIATIVE

Testing reveals cognitive deficits in **asymptomatic** athletes within 4 days post-concussion.



N=215, MANOVA, p<.000000
(Fazio, Lovell, Collins, et al., Neurorehabilitation, 2007)

2006 Van Kampen et al.

HS and college athletes 2 days post-Cx

- 64% reported significant increase in PCS
- 83% demonstrated significantly poorer neurocognitive functioning compared to baselines
- Some controls reported more symptoms or had poorer performance on testing, but 0% demonstrated both
- Using a combination of symptom report and testing resulted in best sensitivity- a 28% increase in identification over symptom report alone

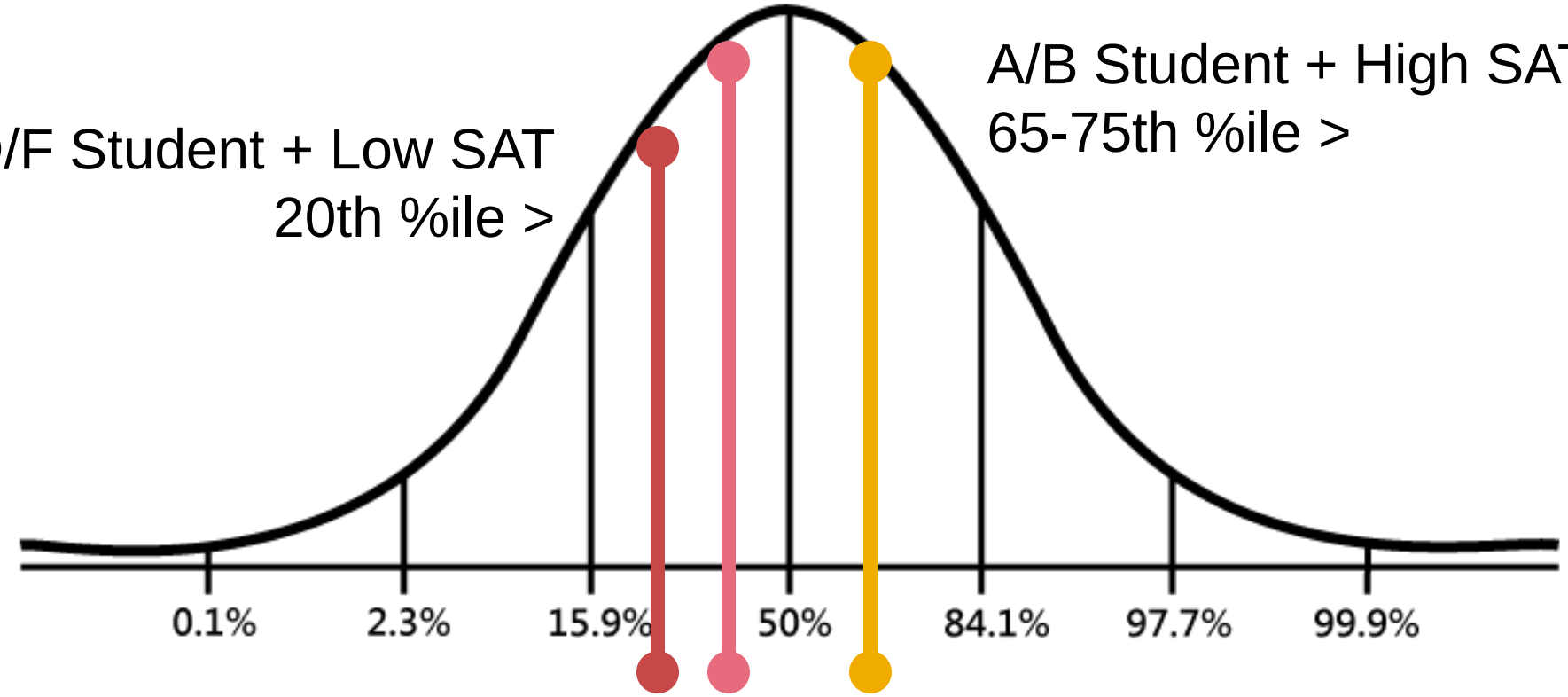
ImPACT Expected Scores

In ADHD- RT, Visual memory and impulse control scores are lower

B/C Student + Avg SAT
35-40th %ile >

A/B Student + High SAT
65-75th %ile >

D/F Student + Low SAT
20th %ile >



Why do Baseline Assessment?

- 30% of non-Cx athletes could not name the date
- 50% of HS athletes could not perform serial 7s
- 20% report HA routinely during games
- LD and ADHD, other premorbid individual variation

Neuropsych Testing in Predicting Recovery

- 94% chance with three low ImPACT composite scores, recovery will be =/> 2 weeks
- RT of .80 or higher- 3 weeks+ to recover
- Cognitive impairment most predictive of long recovery
- Of Symptoms, fogginess is most predictive of long recovery

Computerized Testing

- Advantages
  - Test multiple athletes at same time for baseline
  - Data easily stored and retrieved for post-Cx review
  - Accurate evaluation of reaction time (1/100th of a second as compared to 1-2 seconds for P/P tests)
  - Practice effects reduced through randomization (and multiple forms)

Disadvantage

Baseline testing in groups is problematic

Students can sandbag test

Test-retest reliability not great for memory composite >0.5

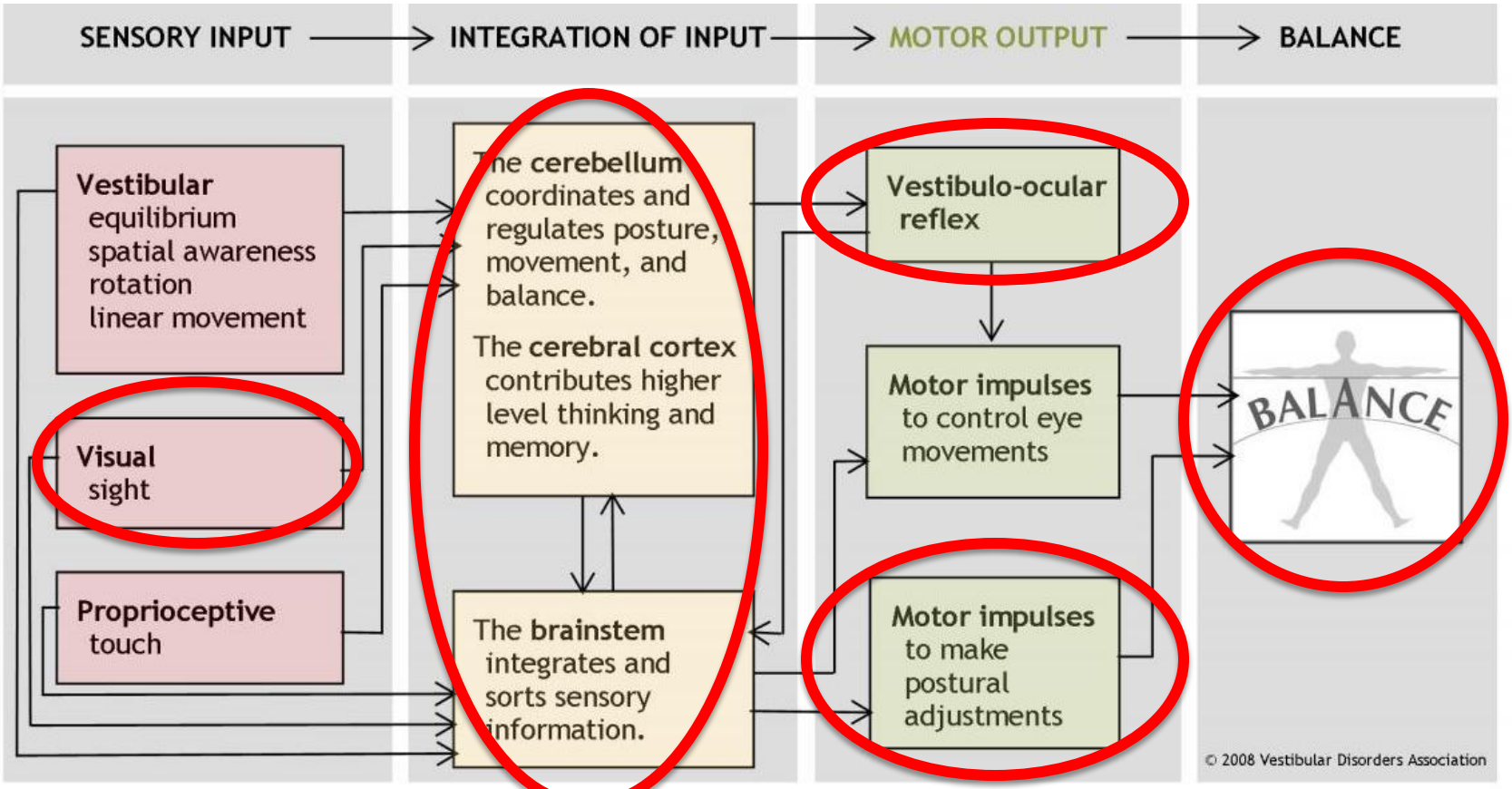
What other tools are available to help you?

- BESS- Balance Error Scoring System
- VOMS-Vestibulo-ocular Motor Symptoms
- SWAY app
- King-Devick
- ImPact test

VOMS™
King-Devick™
BESS Test
SWAY app™
ImPACT™

Concussion Assessment Tools

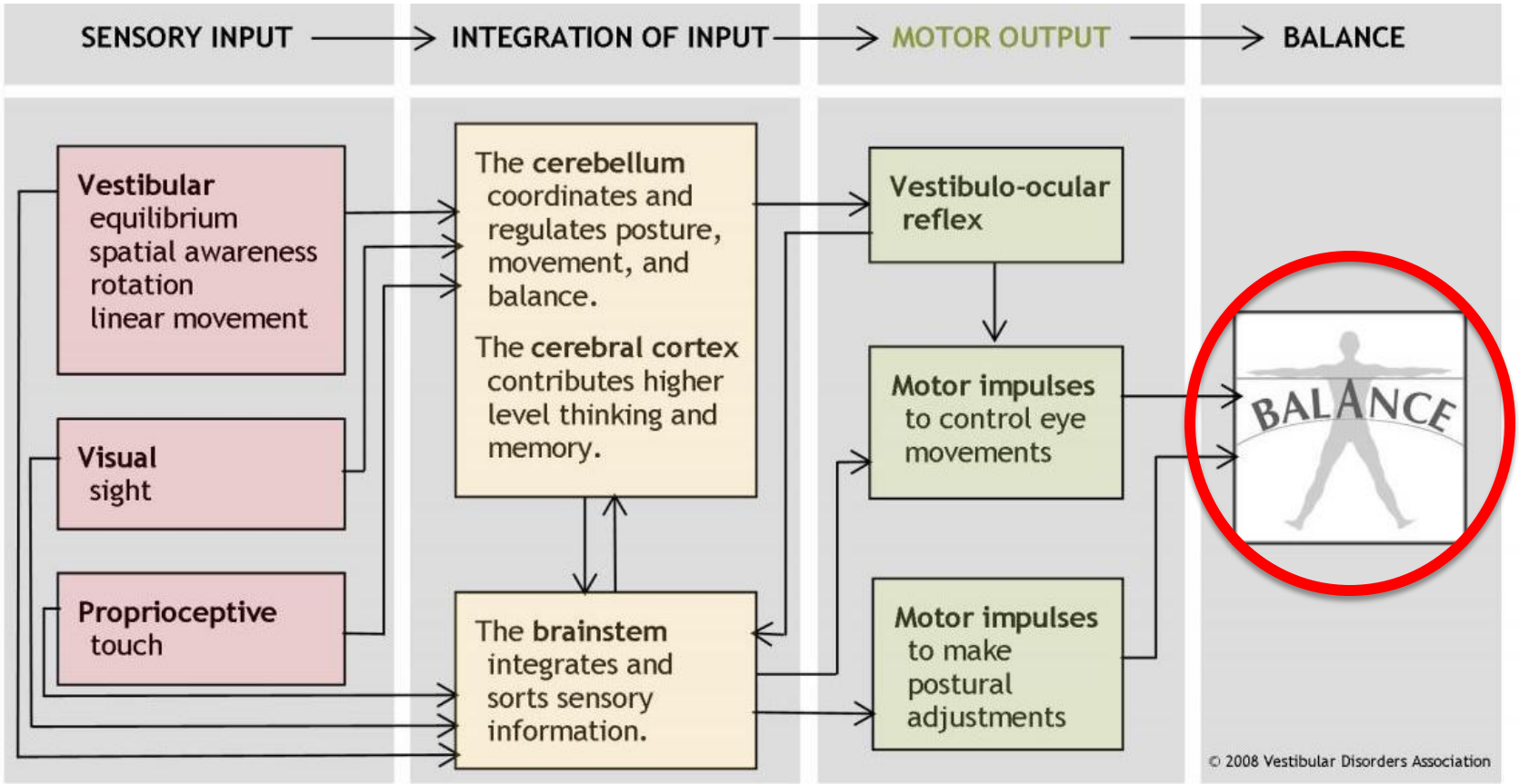
What does it Take to remain Standing?



MAINE CONCUSSION MANAGEMENT INITIATIVE

Balance Evaluation

What does it takes to remain Standing?



MAINE CONCUSSION MANAGEMENT INITIATIVE

BALANCE ERROR SCORING SYSTEM

- The BESS consists of 3 tests lasting 20 seconds each, performed on two different surfaces, firm and foam, eyes closed. Hands on hip:
  - Double leg stance/feet together
  - Single-leg stance using the non-dominant foot
  - Heel-toe stance with the non-dominant foot in the rear (tandem stance)
- Number of balance errors
  - opening the eyes
  - hands coming off hips
  - a step, stumble or fall
  - moving the hips more than 30 degrees
  - remaining out of testing position for more than 5 seconds

**Need baseline

MAINE CONCUSSION MANAGEMENT INITIATIVE

BESS

MAINE CONCUSSION MANAGEMENT INITIATIVE

Balance Error Scoring System (BESS)

Developed by researchers and clinicians at the University of North Carolina's Sports Medicine Research Laboratory, Chapel Hill, NC 27599-8700

- Types of Errors:
  1. Hands lifted off iliac crest
  2. Opening eyes
  3. Step, stumble, or fall
  4. Moving hip into > 30 degrees abduction
  5. Lifting forefoot or heel
  6. Remaining out of test position >5 sec
- The BESS is calculated by adding one error point for each error during the 6 20-second tests.
- Which foot was tested: Left Right

MAINE CONCUSSION MANAGEMENT INITIATIVE

BESS SCORE CARD:

(# errors)

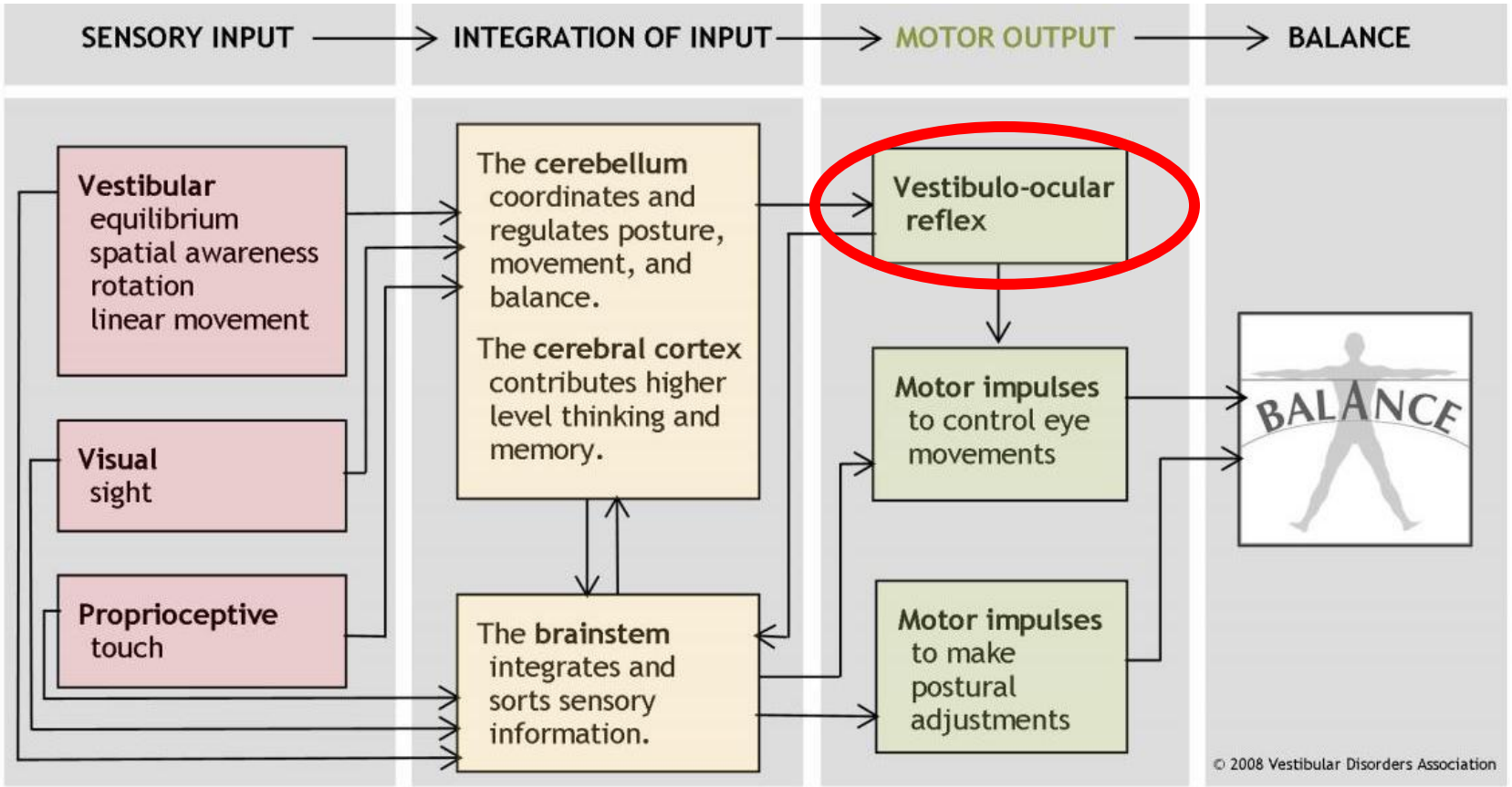
- FIRM Surface
- FOAM Surface
- Double Leg Stance (feet together)
- Single Leg Stance (non-dominant foot)
- Tandem Stance (non-dom foot in back)
- Total Scores:
- BESS TOTAL:

Problems with BESS

- Must have baseline
- Difficult to score with high variability among observers
- Takes a lot of time to complete especially on the sideline
- Appears to have a learned effect in older athletes
- Fatigue changes the score greatly

Vestibulo-Ocular Reflex

Vestibulo-Ocular Reflex



MAINE CONCUSSION MANAGEMENT INITIATIVE

VESTIBULAR/OCULAR-MOTOR SCREENING VOMS

Developed as a Symptom Provocation Tool- Primary Function is to illicit or worsen symptoms with VOR/Eye movement exercises

Mucha A, Collins MW, Elbin RJ. A Brief Vestibular Ocular Motor Screening (VOMS) Assessment to Evaluate Concussions. *A J Sports Med.* 2014; XX(X); 1-8.

VESTIBULAR/OCULAR-MOTOR SCREENING VOMS

- Smooth Pursuits - Tests the ability to follow a slowly moving object.
- Horizontal and vertical saccades - Tests the ability of the eyes to move quickly between targets
- Horizontal and vertical vestibular ocular reflex (VOR) - Assesses the ability to stabilize vision as the head moves
- Convergence - Measures the ability to view a near target without double vision:
- Visual motor sensitivity - Tests visual motion sensitivity and the ability to inhibit vestibular-induced eye movements: "pursuit of thumb"

Mucha A, Collins MW, Elbin RJ. A Brief Vestibular Ocular Motor Screening (VOMS) Assessment to Evaluate Concussions. *A J Sports Med.* 2014; XX(X); 1-8.

VESTIBULAR/OCULAR-MOTOR SCREENING VOMS

Smooth Pursuits

Horizontal and Vertical

- Both pt. and examiner seated.
- Finger 3 ft. from the patient.
- Examiner **MOVES THE TARGET** 1.5 ft. to the right and 1.5 ft. to the left of midline-1 repetition=Left/right/left
- 4 sec per repetition -2 sec L to R 2 sec R to L
- 2 repetition

VESTIBULAR/OCULAR-MOTOR SCREENING VOMS

Saccades-horizontal and vertical

- Fingertips -3 ft. from the patient, and 1.5 ft. to the right and 1.5 ft. to the left- *patient must gaze 30 degrees to left and 30 degrees to the right.*
- patient to **MOVES THEIR EYES** as quickly as possible from point to point.
- 1 repetition= Left/Right/Left
- 10 repetitions are performed.

VESTIBULAR/OCULAR-MOTOR SCREENING VOMS

Vestibular Ocular Reflex (VOR)

- 14 point font size object-midline at a distance of 3 ft.
- Pt. **MOVES HEAD** 20 degrees to each side while maintaining focus on the target.
- Rate= 180 beats/minute (one beat in each direction).
- 1rep = L/R/L
- 10 repetitions are performed.

VESTIBULAR/OCULAR-MOTOR SCREENING VOMS

Convergence

- 14 point font size- arm's length and slowly brings it toward the tip of their nose.
- Stop when they see two distinct images or when the examiner observes an outward deviation of one eye*. Blurring of the image is ignored*
- Distance in cm. between target and the tip of nose is measured
- Repeated 3 times with measures recorded each time.

VESTIBULAR/OCULAR-MOTOR SCREENING VOMS

Visual motor sensitivity
"pursuit of thumb"

- Standing with feet shoulder width apart- facing a busy area of the clinic.
- Arm outstretched and focuses on their thumb.
- patient **ROTATES THEIR HEAD/EYES/TRUNK** 80 degrees to the right and 80 degrees to the left
- At 50 beats/min (one beat in each direction).
- 1 rep= L/R/L
- 5 repetitions.

VOMS SCORING

Measure symptom score at Baseline and after each test

Vestibular/Ocular-Motor Screening (VOMS) for Concussion

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A					
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2: _____ Measure 3: _____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

Instructions:

VOMS CONCLUSIONS

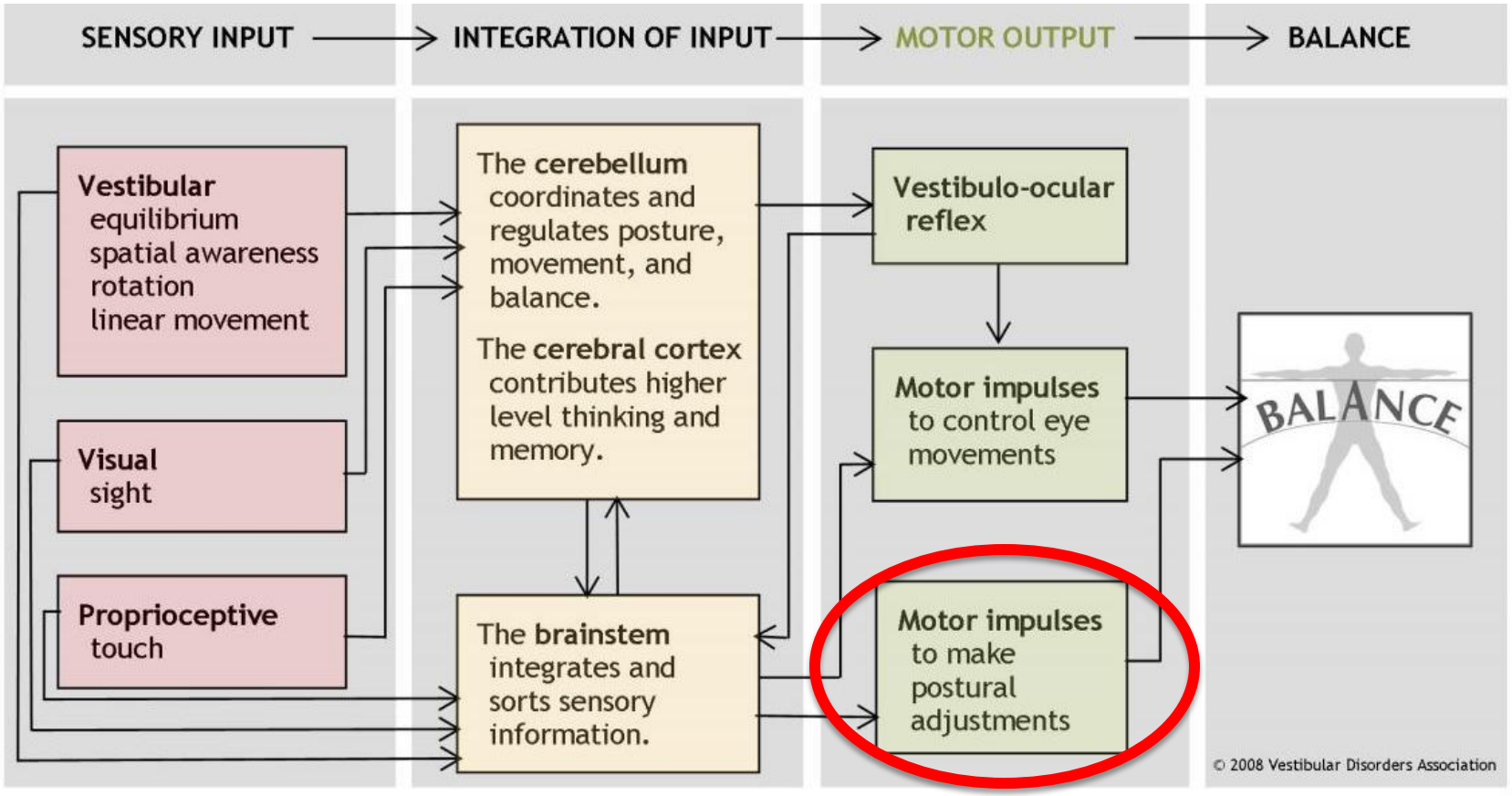
- Reliable and sensitive screening tool within the first week following mTBI
- Has a 90% positive prediction for athletes with mTBI
- Limitations of some subjectivity in symptom reporting
- Need for future research examining the utility of VOMS for acute and sideline assessment

Postural Sway

the phenomenon of constant displacement and correction of the position of the center of gravity within the base of support.

Historically has been assessed using Force Plate Technology by measuring Center of Pressure and Normalized Path Length

SWAY



MAINE CONCUSSION MANAGEMENT INITIATIVE

SWAY™ Balance Application

- Smartphone Application- Baseline and Post Injury Postural Sway Assessment
  - Assessment of postural Sway
  - Reaction Time]
  - Post injury Symptom Score
- Sway-Eyes Closed
  - Feet together-
  - Tandem Stance- Right and Left foot forward
  - Single Leg Stance- Right and Left foot
- 5 Reaction Time trials- Composite score of all 5
- Symptom Score- 22 Items post injury

MAINE CONCUSSION MANAGEMENT INITIATIVE

Does it Work

1. NO PEER REVIEWED LITERATURE supporting its use in concussion assessment
2. PEER REVIEWED LIT on test- retest reliability of accelerometers
3. PEER REVIEWED LIT on delayed RT in concussion
4. CONTRADICTORY LIT on SWAY and Concussions

MAINE CONCUSSION MANAGEMENT INITIATIVE

Saccade Eye Movement

Saccade Eye Movement

- A **saccade** (/sɨˈkɑːd/ *sə-**KAHD***, French for *jerk*) is quick, simultaneous movement of both eyes between two phases of fixation in the same direction
- When scanning immediate surroundings or reading, human eyes make jerky saccadic movements and stop several times, moving very quickly between each stop. The speed of movement during each saccade cannot be controlled; the eyes move as fast as they are able. Up to 900 degree/second
- One reason for the saccadic movement of the human eye is that the central part of the retina—known as the fovea—which provides the high-resolution portion of vision is very small in humans, only about 1~2 degrees of vision, but it plays a critical role in resolving objects. By moving the eye so that small parts of a scene can be sensed with greater resolution, body resources can be used more efficiently.

Saccade Eye Movement

- Saccade Eye Movement speed is not under voluntary control
- Good measure of simple reaction time
- Concerns about learning effect and sand bagging

King-Devick Test

- Initially developed for reading assessment of Kindergarten
- Began to be used for Concussion assessment
- Uses Time to complete 3 trials
- Generally reliable changes in concussed athletes

KING DEVICK PROCEDURE

- LOG IN
- Calibrate your screen
- Enroll athletes
- Download Score Sheets
- Have Students Take Baseline 3 x
- Score Errors while recording time

KING-DEVICK TEST®

In association with Mayo Clinic

King-Devick Concussion Screening Test
Score Sheet - Version 1

Subject Name/ID Number:_____ **Date of Birth:**_____

Subject's Baseline Time:_____ **Baseline Date:**_____

Team/Sport:_____ **Comments:**_____

Scoring King-Devick Test

When testing, start the timer when the subject reads the first number on the test card and stop the timer when the subject reads the last number on the test card. Repeat for all test cards. Do not include the time between completing individual test cards. Total Time is the total testing time for all three test cards combined.

Answer Key Test Card I	Answer Key Test Card II	Answer Key Test Card III
2 – 5 – 8 – 0 – 7	3 – 7 – 5 – 9 – 0	5 – 4 – 1 – 8 – 0
3 – 7 – 9 – 4 – 6	2 – 5 – 7 – 4 – 6	4 – 6 – 3 – 5 – 9
5 – 3 – 1 – 6 – 4	1 – 4 – 7 – 6 – 3	7 – 5 – 4 – 2 – 7
7 – 9 – 7 – 3 – 5	7 – 9 – 3 – 9 – 0	3 – 2 – 6 – 9 – 4
1 – 5 – 4 – 9 – 2	4 – 5 – 2 – 1 – 7	1 – 4 – 5 – 1 – 3
6 – 5 – 5 – 7 – 3	5 – 3 – 7 – 4 – 8	9 – 3 – 4 – 8 – 5
3 – 1 – 8 – 6 – 4	7 – 4 – 6 – 5 – 2	5 – 1 – 6 – 3 – 1
5 – 3 – 7 – 5 – 2	9 – 0 – 2 – 3 – 6	4 – 3 – 5 – 2 – 7

Establishing A King-Devick Test Baseline

*Administer the King-Devick Test TWICE using the scoring instructions. The fastest TOTAL TIME of the TWO trials without errors should be recorded as the subject's Baseline Time.**

Baseline Attempt Time #1	Baseline Attempt Time #2	*Subject's Baseline Time
Total Time:_____	Total Time:_____	Total Time:_____
Test Cards:_____	Test Cards:_____	Test Cards:_____
Tester Initials:_____	Tester Initials:_____	Tester Initials:_____

Testing After A Suspected Head Trauma

Administer the test ONCE using the same number of test cards used in Baseline Testing

If the subject performs **SLOWER** than the baseline or has **ANY** errors, the subject should be ***Removed-From-Play*** and referred to a health care professional for additional evaluation.

If the subject performs **FASTER** than the Baseline Time **WITHOUT** errors, the Total Time will become the subject's new Baseline Time.

Date:_____	**Date:**_____	**Date:**_____
Total Time:_____	**Total Time:**_____	**Total Time:**_____
Total Errors:_____	**Total Errors:**_____	**Total Errors:**_____
Test Cards:_____	**Test Cards:**_____	**Test Cards:**_____
Tester Initials:_____	**Tester Initials:**_____	**Tester Initials:**_____
Comments:_____	**Comments:**_____	**Comments:**_____

King-Devick Test is for screening purposes only and any suspicion or indication of head trauma should be evaluated by a licensed professional.

2 5 8 0 7

3 7 9 4 6

5 3 1 6 4

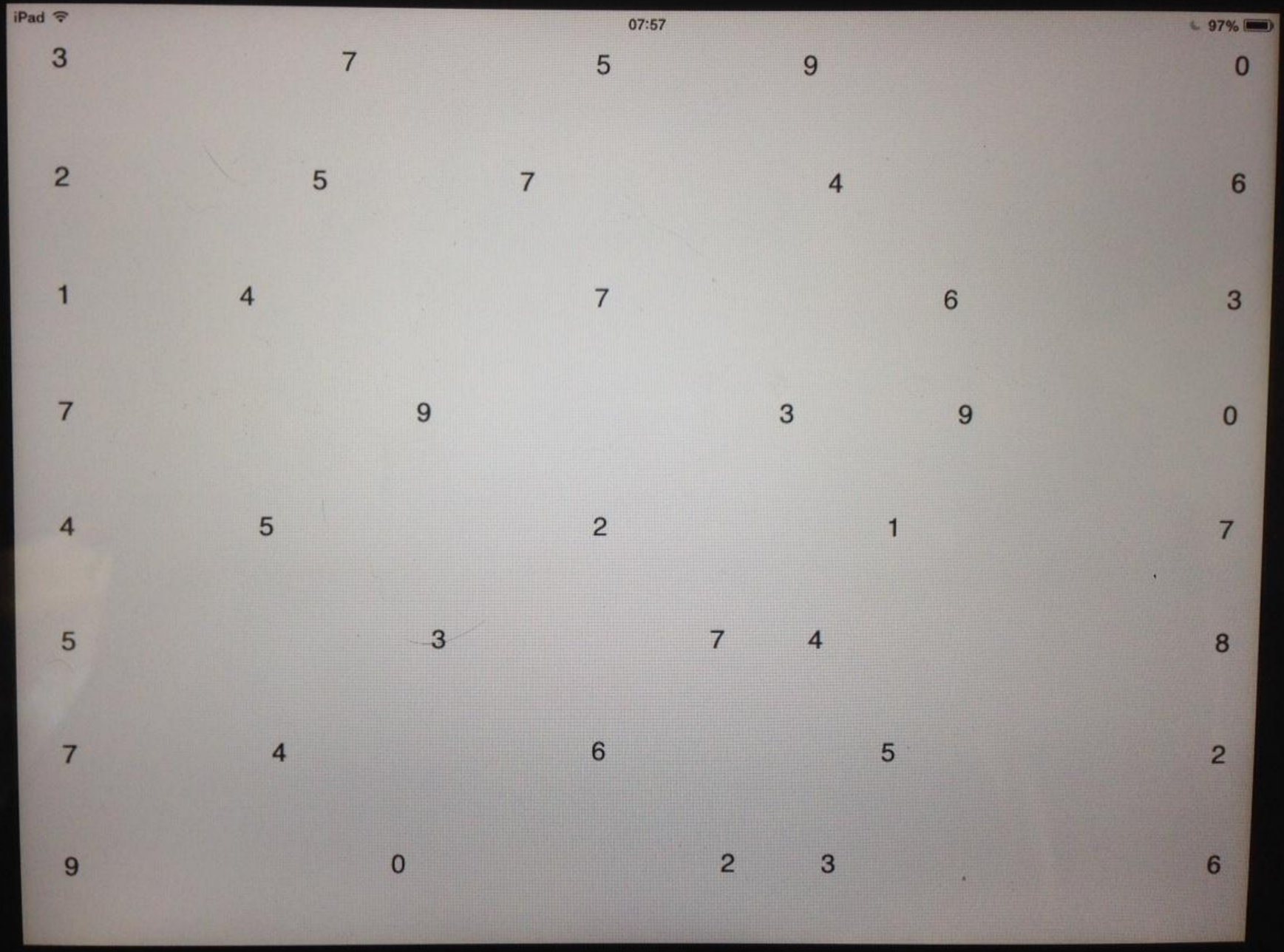
7 9 7 3 5

1 5 4 9 2

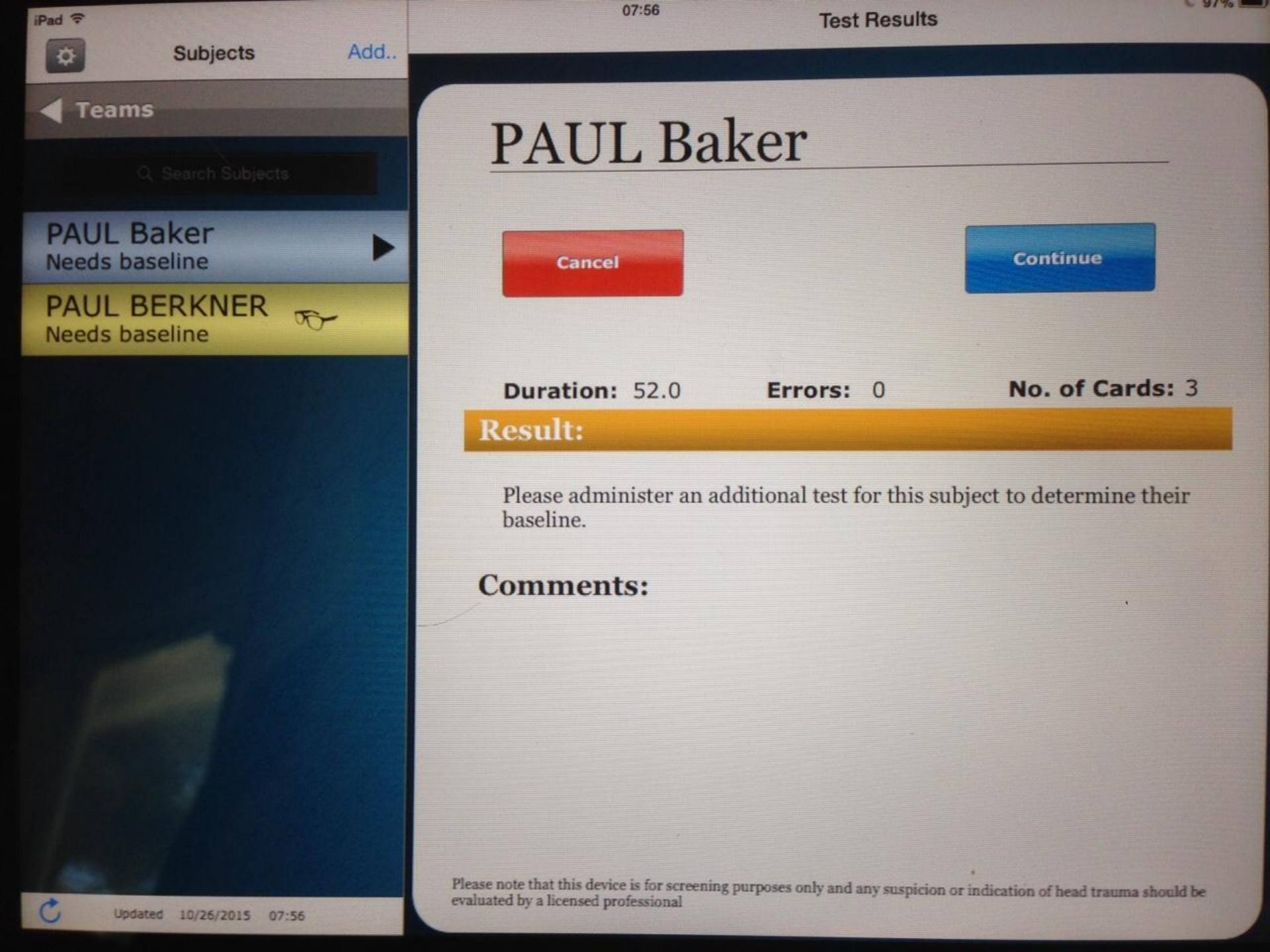
6 5 5 7 3

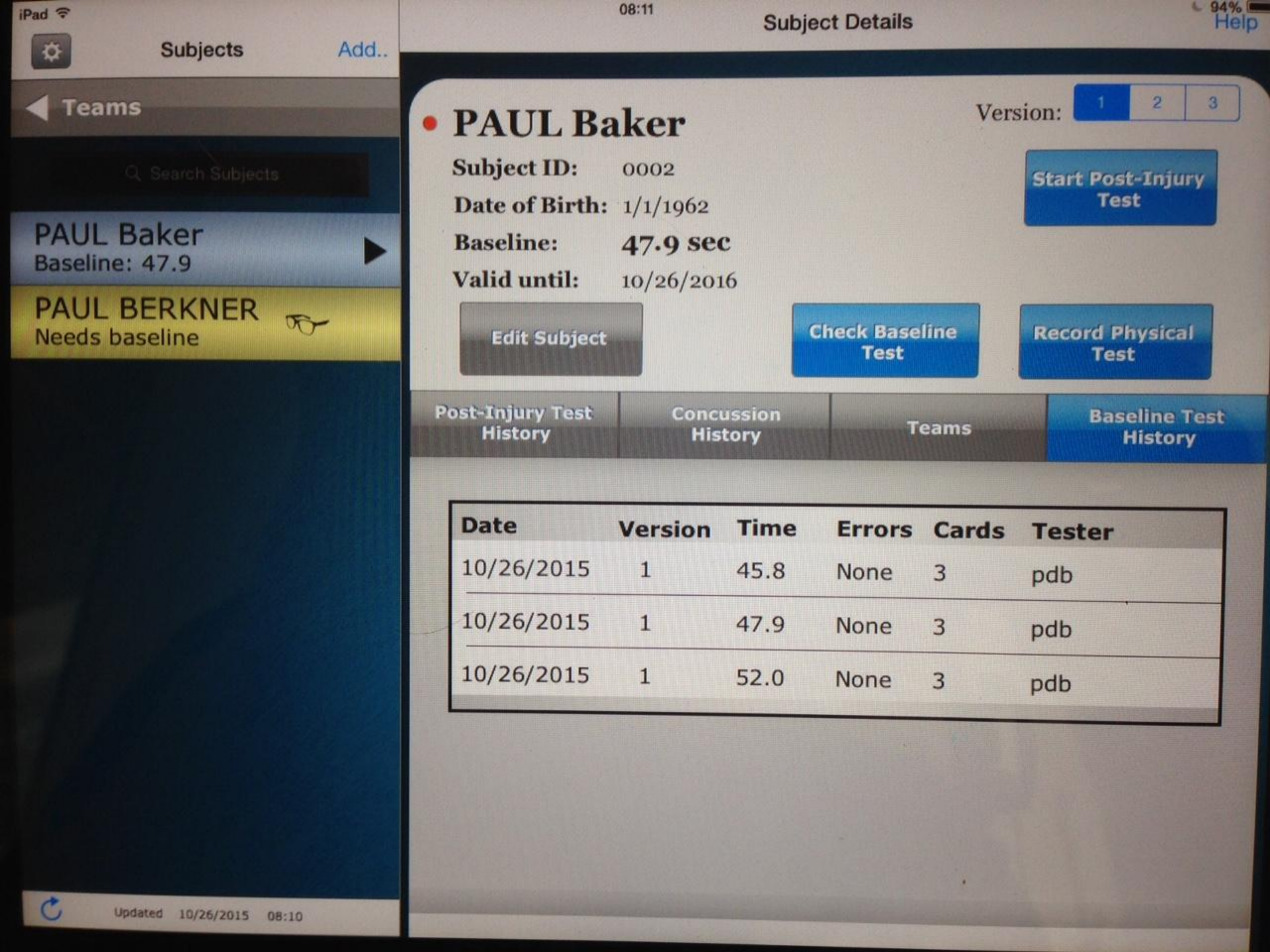
3 1 8 6 4

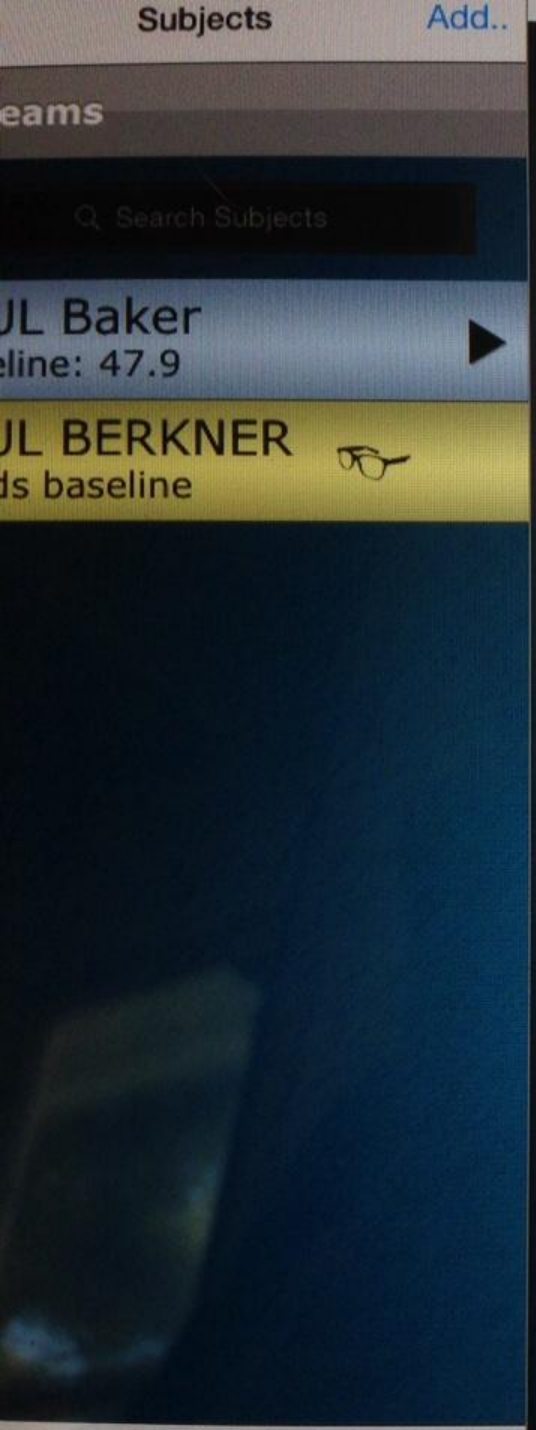
5 3 7 5 2


iPad
07:57
97%
3 7 5 9 0
2 5 7 4 6
1 4 7 6 3
7 9 3 9 0
4 5 2 1 7
5 3 7 4 8
7 4 6 5 2
9 0 2 3 6

5			4		1			8	0
4		6				3		5	9
7			5				4	2	7
3		2			6			9	4
1			4			5		1	3
9				3	4			8	5
5	1					6		3	1
4				3		5	2		7


iPad
07:56
Test Results
Subjects
Add..
Teams
Search Subjects
PAUL Baker
Needs baseline
PAUL BERKNER
Needs baseline
Updated 10/26/2015 07:56
PAUL Baker
Cancel
Continue
Duration: 52.0
Errors: 0
No. of Cards: 3
Result:
Please administer an additional test for this subject to determine their baseline.
Comments:
Please note that this device is for screening purposes only and any suspicion or indication of head trauma should be evaluated by a licensed professional


iPad
08:11
94%
Subjects
Add..
Subject Details
Help
Teams
Search Subjects
PAUL Baker
Baseline: 47.9
PAUL BERKNER
Needs baseline
Updated 10/26/2015 08:10
PAUL Baker
Version:
1
2
3
Subject ID: 0002
Date of Birth: 1/1/1962
Baseline: 47.9 sec
Valid until: 10/26/2016
Start Post-Injury Test
Edit Subject
Check Baseline Test
Record Physical Test
Post-Injury Test History
Concussion History
Teams
Baseline Test History
Date Version Time Errors Cards Tester
10/26/2015 1 45.8 None 3 pdb
10/26/2015 1 47.9 None 3 pdb
10/26/2015 1 52.0 None 3 pdb



PAUL Baker

Cancel

Continue

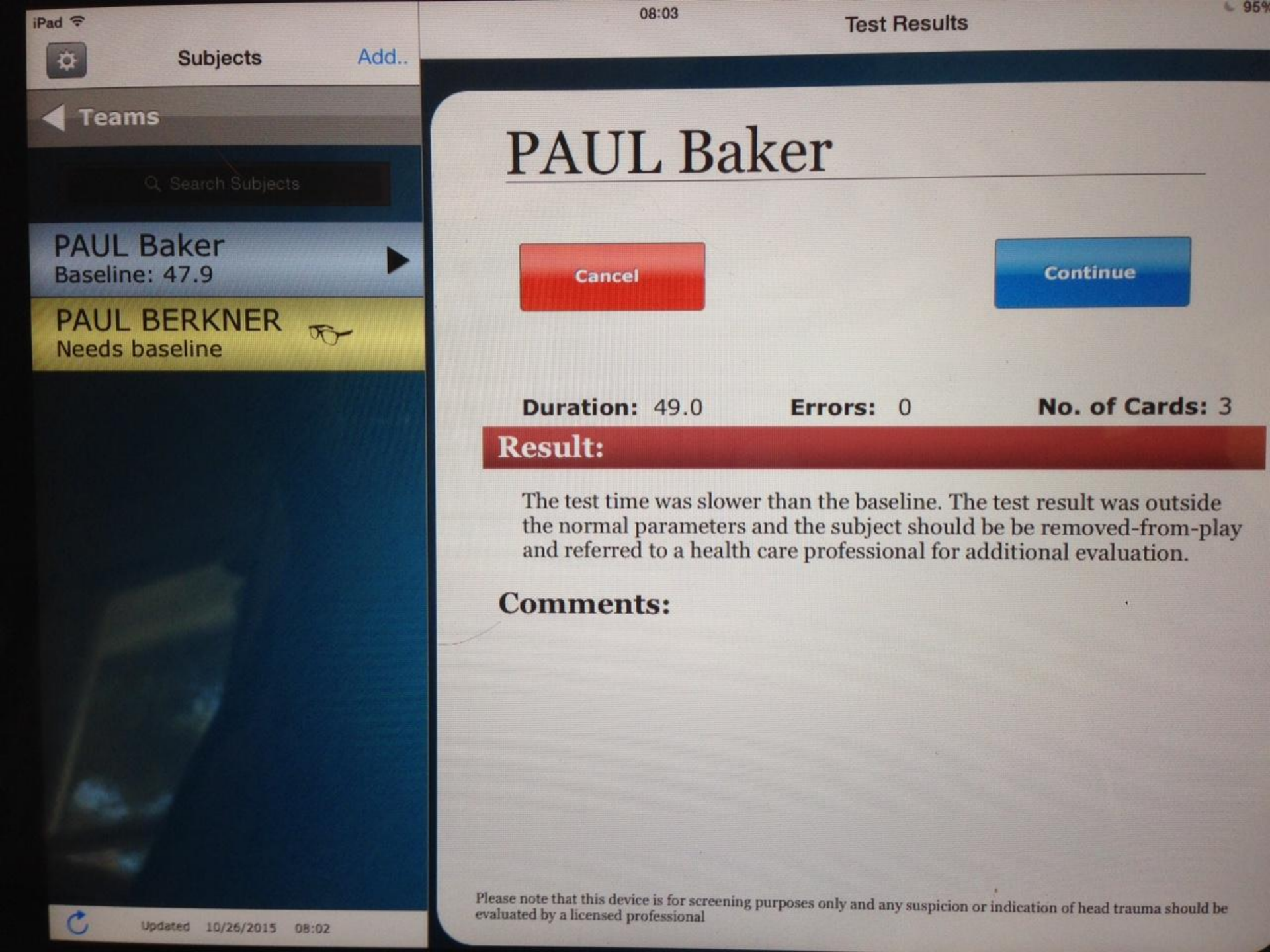
Duration: 53.0 **Errors:** 5 **No. of Cards:** 3

Result:

The subject committed errors. This result is considered outside the normal parameters. The subject should be removed-from-play and referred to a health care professional for additional evaluation.

Comments:

Please note that this device is for screening purposes only and any suspicion or indication of head trauma should be evaluated by a licensed professional


iPad
08:03
95%
Subjects
Add..
Teams
Search Subjects
PAUL Baker
Baseline: 47.9
PAUL BERKNER
Needs baseline
Updated 10/26/2015 08:02
Test Results
PAUL Baker
Cancel
Continue
Duration: 49.0
Errors: 0
No. of Cards: 3
Result:
The test time was slower than the baseline. The test result was outside the normal parameters and the subject should be be removed-from-play and referred to a health care professional for additional evaluation.
Comments:
Please note that this device is for screening purposes only and any suspicion or indication of head trauma should be evaluated by a licensed professional

Summary of K-D

- Initial Validation Studies for use in **Sideline Assessment** of Concussion promising- boxer/MMA, rugby , football
- Requires Baseline
- Generally good Test/Retest in short term
- Learning effect relatively high

MAINE CONCUSSION MANAGEMENT INITIATIVE

Your evaluation shows

- Normal Neuro exam
- Post Concussion Symptom score=10
- VOMS- no provocation of symptoms
- BESS- no baseline but essentially normal
- ImPact testing most likely abnormal
- Female basketball player
  - 1 concussion
  - History of Headache treatment
  - School work not at baseline

MAINE CONCUSSION MANAGEMENT INITIATIVE

Next steps?

- Academic
- Athletic
- Activity
- Treatment
- Consultation

- Recommend 504 plan
- Restrict Basketball
- Consider Sub-symptom exercise
- Evaluate symptoms cluster
- If not improving with above consider neuro-psych eval

MAINE CONCUSSION MANAGEMENT INITIATIVE

When to exercise after concussion

A Preliminary Study of Subsymptom Threshold Exercise Training for Refractory Post-Concussion Syndrome

- 12 patients- 6 athletes/6 non-athletes
- Baseline testing- Treadmill test to symptom threshold- maximal HR/Systolic BP with S/S
- 5-6 days/week of 80% of ST HR/Systolic Blood Pressure
- Retest-Exercise treadmill to ST at 3 week intervals
- Results-Improved exercise HR/SBP in all subjects
  - Athletes improved faster than non-athletes- 25 +/-8 days vs 74.8 +/- 27.2
  - Rate of improvement was related to Increase in peak HR
  - All patients had symptom reduction and no pt. had adverse outcomes

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RTP PRINCIPLES AND DECISIONS: WHEN TO HALT "RTP"

- How many is "too many"? When do you permanently pull a student athlete from contact or collision sports for good?
- Three concussions in a career, three in a season? One severe concussion lasting a year?
- What if neurocognitive testing never returns to baseline?
- What if the athlete is 18 and an adult?

Conclusions/Key Points

- Concussions are common and often unreported
- There are complex changes in the brain with concussion, affecting short and long term function
- Highly variable recovery times/prognosis, many factors contribute
- Initial management is cognitive and physical rest
- Treat symptoms!
- Follow Zurich return to play stepwise progression once truly back to baseline
- Consider cessation of contact/collision sports for athletes with recurrent or severe concussions