Concussion Evaluation:
From Sidelines to Clinic

Kevin D. Walter, MD, FAAP

Associate Professor, Medical College of Wisconsin Department of Orthopaedic Surgery

Program Director, Children's Wisconsin Sports Medicine

Medical Director, Children's Wisconsin Sports Physical Therapy

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Disclosures

- I have no financial disclosures
- I do work for/with the Wisconsin Interscholastic Athletic Association, the NFL, and the Green Bay Packers – the opinions discussed today are mine and do not necessarily reflect the opinions of those organizations.

Objectives

FOCUSED SESSION ON A PORTION OF CONCUSSION – ONE OF SEVERAL TO COME

- Learn best practices for sideline assessment of potential concussion
- Learn when to activate EMS
- Understand the differences between sideline and in-clinic assessment

Why Do We Need More on Concussion?

- **Lempke et al (2020 J Athl Train)**
  - ATs scored 78% on average in recognizing concussion signs & symptoms
  - 49% of ATs would allow a player with a normal neuro exam and denying symptoms to return to play when the player reported “I just got my bell rung”.
  - ATs with more clinical experience are less likely to use standardized tools when evaluating concussion
- **Kerr et al (2016 JAMA Peds)**
  - 10% of youth athletes return to play in <24 hours
  - 1% of high school
  - 5% of college

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It's "easy" to spot

- McCrea et al (2016 Clin J Sport Med)
  - 70% HS football players reported concussion
    - Why not 100%?
      - Did not want to be pulled
      - Afraid of coaches, parents, and teammates

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Definition

There is truly not a universally accepted definition

1. Direct blow to head, face, neck or elsewhere on body with impulsive force transmitted to head.
2. Typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously. However, in some cases signs & symptoms may evolve over minutes to hours.
3. Largely reflect a functional disturbance rather than a structural injury (normal standard neuroimaging studies).
4. Results in a range of clinical signs and symptoms that may or may not involve LOC. Resolution follows a sequential course and some cases may be prolonged.
5. Clinical signs and symptoms cannot be explained by drug, alcohol, or medication use; other injuries (ex: cervical spine); or other comorbidities (ex: psychological factors or coexisting medical disorder).

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Signs

- LOC
- Confused / Dazed
- Behavior / Personality changes
- Glassy eyed
- Repeating questions
- Answers questions slowly

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Symptoms

COGNITIVE	PHYSICAL	EMOTIONAL	SLEEP
Confusion	Headache	Irritable	Hard to fall asleep
Disoriented	Nausea / Vomiting	Sad	Wakes at night
Amnesia	Dizzy	Nervous	More fatigued
Distractible	Fatigue	Mood swings	
Foggy	Vision changes	More emotional	
Slow response	Photo- / phono-phobia		
	Numbness / Tingling		

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What To Do?

- Be prepared!
- Know state law, rules & guidelines
- Preseason conversations
  - Coaches, athletes, parents
  - “Normal” recovery for adolescents is ≤30 days
- Have material ready for the sideline
- Have an Emergency Action Plan for each venue
  - Rehearse them

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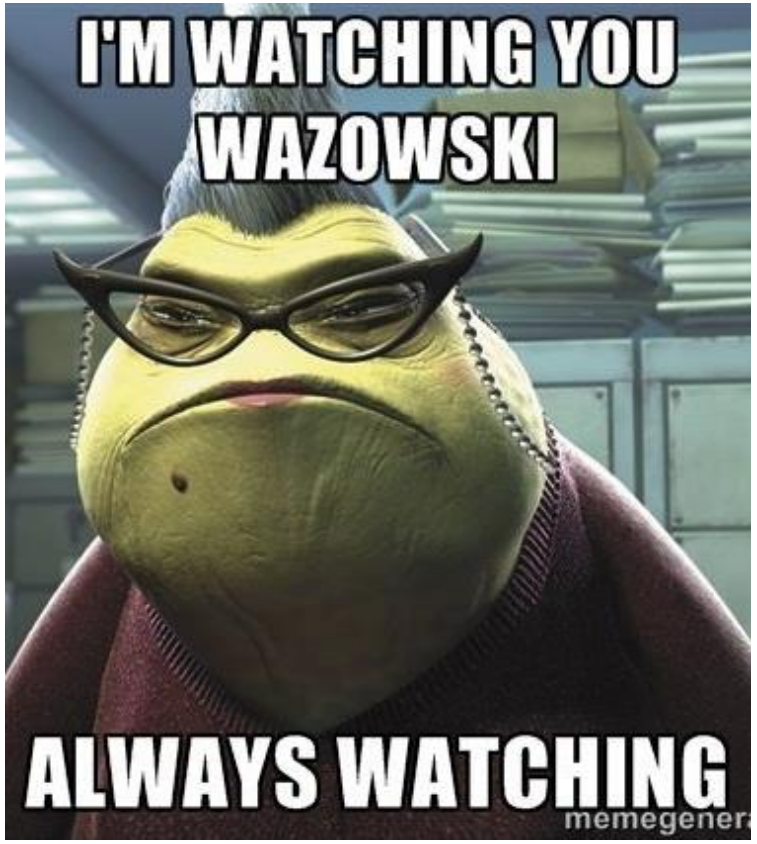
Always Watching

- Keep eyes on the athletes
  - Encourage self-reporting and reporting teammates
  - Even off the ball
  - Look for injury
    - Slow to get up
    - Holding head
    - Acting differently or confused
- Always seek athlete out and engage with questions
- Always alert coaches
- Consider taking away equipment



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No-Go Criteria

- LOC
- Posturing or post-traumatic seizure
- Gross Motor Instability
- Confusion
- Amnesia
- Symptoms or abnormal evaluation
- “When in doubt, hold them out”

- NEVER RETURN TO PLAY ON SAME DAY
- NEVER RETURN TO PLAY WITH SYMPTOMS

Sideline Evaluation

- Neurologic examination, assess symptoms, cognition, balance, and vision
- Ideally done in a private, quiet area
- Ideally done by or with a person that knows the athlete (better suited to identify subtle changes)

- ABC's
- Assess neck
  - LOC is assumed c-spine injury

SCAT 5

- Child SCAT 5 (5-12y)
- Free
- Takes 10+ minutes
- Consider having a baseline SCAT 5 and BESS
  - Normative data is available for both BESS and SCAT 5 that has good specificity and sensitivity

IMMEDIATE SIDELINE ASSESSMENT

1. Red Flags
2. Observable Signs

Lying motionless on the playing surface	Y	N
Balance / gait difficulties / motor incoordination: stumbling, slow / laboured movements	Y	N
Disorientation or confusion, or an inability to respond appropriately to questions	Y	N
Blank or vacant look	Y	N
Facial injury after head trauma	Y	N

SCAT 5

3. Maddocks Questions

"I am going to ask you a few questions, please listen carefully and give your best effort. First, tell me what happened?"

Mark Y for correct answer / N for incorrect

What venue are we at today?	Y	N
Which half is it now?	Y	N
Who scored last in this match?	Y	N
What team did you play last week / game?	Y	N
Did your team win the last game?	Y	N

4. Glasgow Coma Scale

Best eye response (E)	
No eye opening	1
Eye opening in response to pain	2
Eye opening to speech	3
Eyes opening spontaneously	4
Best verbal response (V)	
No verbal response	1
Incomprehensible sounds	2
Inappropriate words	3
Confused	4
Oriented	5
Best motor response (M)	
No motor response	1
Extension to pain	2
Abnormal flexion to pain	3
Flexion / Withdrawal to pain	4
Localizes to pain	5
Obeys commands	6
Glasgow Coma score (E + V + M)	

SCAT 5 Symptom Scale

	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
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
Nervous or Anxious	0	1	2	3	4	5	6
Trouble falling asleep (if applicable)	0	1	2	3	4	5	6
Total number of symptoms:							of 22
Symptom severity score:							of 132
Do your symptoms get worse with physical activity?						Y	N
Do your symptoms get worse with mental activity?						Y	N
If 100% is feeling perfectly normal, what percent of normal do you feel?							
If not 100%, why?							

SCAT 5 – Cognitive Screening

STEP 3: COGNITIVE SCREENING

Standardised Assessment of Concussion (SAC)[4]

ORIENTATION

What month is it?	0	1
What is the date today?	0	1
What is the day of the week?	0	1
What year is it?	0	1
What time is it right now? (within 1 hour)	0	1
Orientation score		of 5

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SCAT 5 Immediate Recall

I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order. For Trials 2 & 3: I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before.

List	Alternate 5 word lists					Score (of 5)		
						Trial 1	Trial 2	Trial 3
A	Finger	Penny	Blanket	Lemon	Insect			
B	Candle	Paper	Sugar	Sandwich	Wagon			
C	Baby	Monkey	Perfume	Sunset	Iron			
D	Elbow	Apple	Carpet	Saddle	Bubble			
E	Jacket	Arrow	Pepper	Cotton	Movie			
F	Dollar	Honey	Mirror	Saddle	Anchor			
					Immediate Memory Score			of 15
					Time that last trial was completed			

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SCAT 5 - Concentration

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

Concentration Number Lists (circle one)					
List A	List B	List C			
4-9-3	5-2-6	1-4-2	Y	N	0
6-2-9	4-1-5	6-5-8	Y	N	1
3-8-1-4	1-7-9-5	6-8-3-1	Y	N	0
3-2-7-9	4-9-6-8	3-4-8-1	Y	N	1
6-2-9-7-1	4-8-5-2-7	4-9-1-5-3	Y	N	0
1-5-2-8-6	6-1-8-4-3	6-8-2-5-1	Y	N	1
7-1-8-4-6-2	8-3-1-9-6-4	3-7-6-5-1-9	Y	N	0
5-3-9-1-4-8	7-2-4-8-5-6	9-2-6-5-1-4	Y	N	1

- Repeat digits backwards
- Months in reverse order

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.

Dec - Nov - Oct - Sept - Aug - Jul - Jun - May - Apr - Mar - Feb - Jan	0 1
Months Score	of 1
Concentration Total Score (Digits + Months)	of 5

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SCAT 5 – Neurologic Screen

Can the patient read aloud (e.g. symptom check-list) and follow instructions without difficulty?	Y	N
Does the patient have a full range of pain-free PASSIVE cervical spine movement?	Y	N
Without moving their head or neck, can the patient look side-to-side and up-and-down without double vision?	Y	N
Can the patient perform the finger nose coordination test normally?	Y	N
Can the patient perform tandem gait normally?	Y	N

- Finger to nose
  - Seated, eyes open
  - 5 cycles as quick and accurate as possible
- Tandem gait
  - Fails if step off line, separate heel/toe, touch or grab examiner or object

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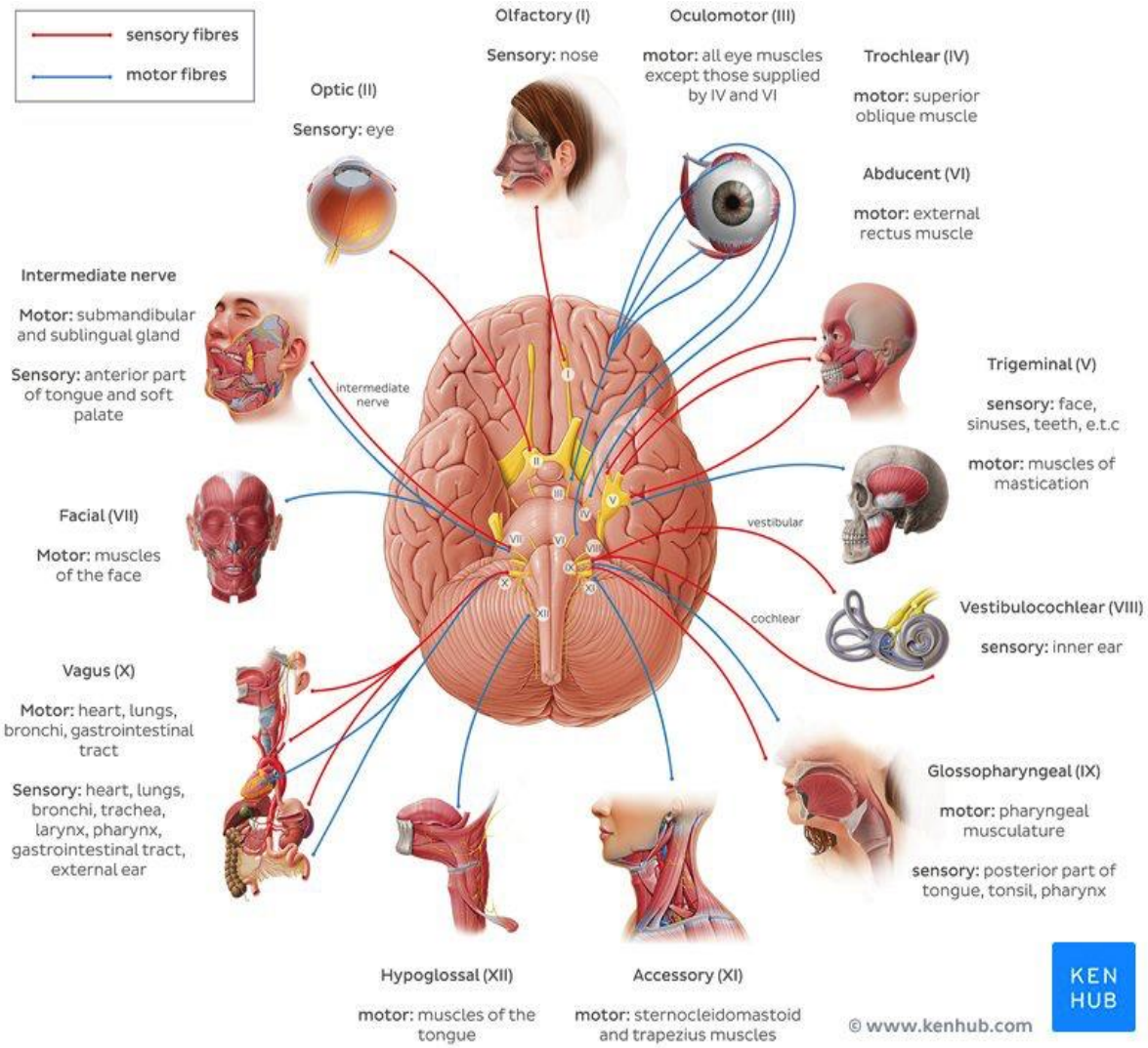
Neurologic Examination

- Alert & oriented x 3
- Affect
- Romberg
- Motor evaluation for weakness
- DTRs
- Sensory exam
- Gait
- Cranial nerve

Cranial Nerve Evaluation



- **1** - *olfactory (not tested)*
- **2** - *vision*
- **3,4,6** - *smooth pursuits*
- **5** - *facial sensation / clenching jaw*
- **7** - *eyelids closing, smiling, puff out cheeks*
- **8** - *hearing*
- **9 & 10** - *symmetric palate elevation / gag response*
- **11** - *shoulder shrug*
- **12** - *extend tongue and move side to side*

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SCAT 5 - Balance

BALANCE EXAMINATION

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

Which foot was tested
(i.e. which is the non-dominant foot)
☐ Left
☐ Right

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

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

Condition	Errors
Double leg stance	of 10
Single leg stance (non-dominant foot)	of 10
Tandem stance (non-dominant foot at the back)	of 10
Total Errors	of 30

- Each phase for 20 sec with hands on hips & eyes closed
- True BESS is barefoot on firm ground & on Foam Pad (Airex Balance Pad 10” x 10” x 2.5”)
- Consider footwear for sport
- Modified BESS is without foam pad

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BESS Scorecard

Score Card

Balance Error Scoring System (BESS)
(Guskiewicz)

Balance Error Scoring System – 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.

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:		

Which **foot** was tested: ☐ Left ☐ Right
(i.e. which is the **non-dominant** foot)

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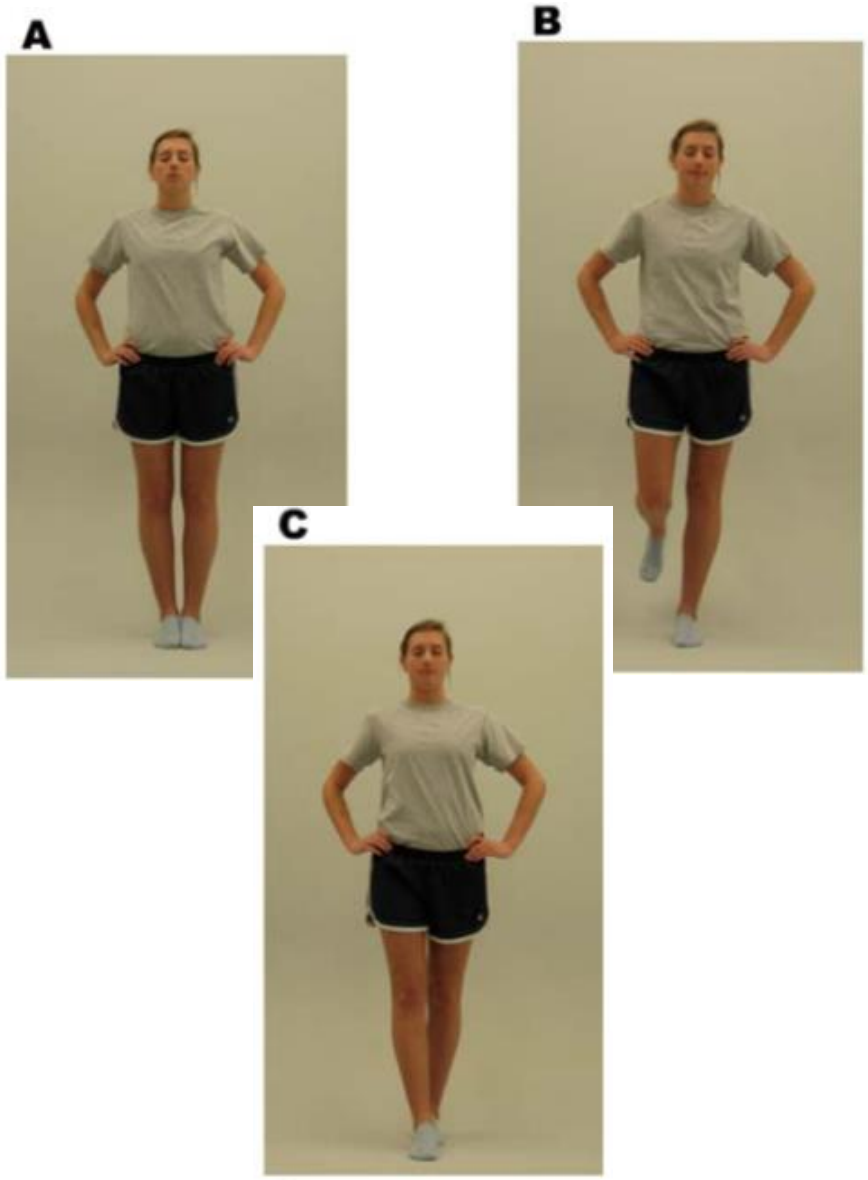
BESS



A. Double leg stance

B. Single leg stance

A. Stand on non-dominant leg (non kicking leg)

B. Knee at 30 degrees

C. Tandem stance

A. Heel to toe

B. Non-dominant foot in front

D. Record errors over 20s

A. Max 10 errors

B. Multiple mistakes at same time = 1 error

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Activate EMS

- LOC
- Abnormal neurologic exam
- Weakness or tingling/burning in arms or legs
- Neck pain or tenderness
- Seizure/convulsion
- Repeated emesis
- Severe headache
- Worsening symptoms (restless, agitated, tired, headache)
- Comfort level (with injury, with psychosocial issues, with environmental concerns)
- ALWAYS send with information & ideally call to handoff

Sending Athlete Home

- No night waking
- Handoff to caregiver
- Be clear that worsening symptoms or concerns herald the need for emergent evaluation
- Educational handout
- Establish follow-up plan
  - Daily check in
  - Medical appointments

When To Refer

- History of multiple concussions (especially prolonged / complicated recovery)
- Comorbid medical and/or neurobehavioral conditions
- Not improved within 7 days
- Comfort level
  - Family, coach, athlete
- 2 studies (2020 Eagle SR & 2020 Kontos AP) showed that patients presenting to physician in ≤7 days had faster recovery than those referred between 8-30 days
- ALWAYS communicate (call, send paperwork, etc.)

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Office – Acute Concussion

- SCAT 5 still quite helpful
  - ➢Symptom Scale
  - ➢Cognitive / memory assessment
- Detailed evaluation of medical history
  - Headache disorder
  - Seizure disorder
  - Neurobehavioral disorders
  - Learning disorders
- Concussion history
  - Previous injuries: MOI? How long? When? Complete recovery?

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Office – Acute Concussion

- Full neurologic evaluation
- Cervical spine evaluation
- Balance Error Scoring System (BESS)
  - Modified version without foam
- Vestibular Ocular Motor Screen (VOMS)
  - Smooth Pursuits
  - Saccades: Horizontal / Vertical
  - Near Point Convergence
  - Vestibular Ocular Reflex: Horizontal / Vertical
  - Visual Motion Sensitivity test

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VOMS - Scorecard

- Record pretest symptoms

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						

VOMS – Smooth Pursuit

- Track slowly moving object
- 3 feet from patient
- Horizontal – 1.5 ft on each side of midline, moving at a 2 sec pace L to R to L
  - Above, at midline, below
- Vertical – same spacing and pace
  - Right, at midline, left

VOMS - Saccades

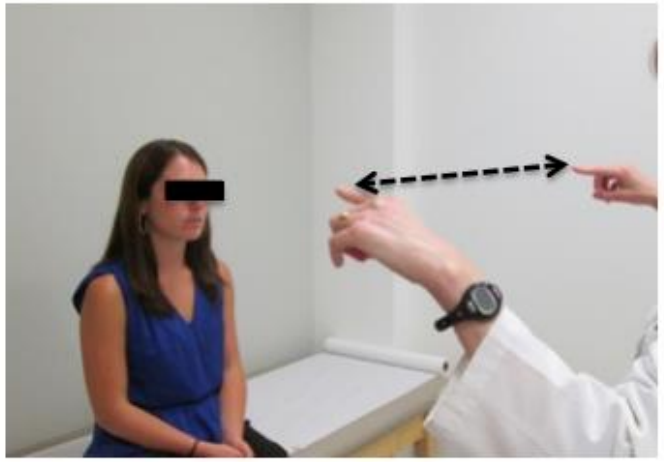

Figure 2. Horizontal saccades.

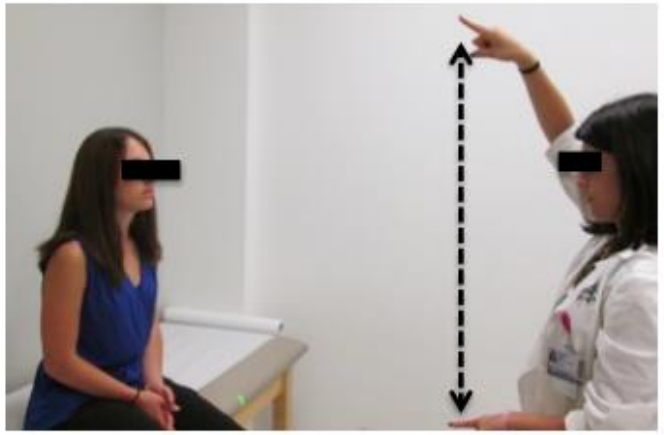

Figure 3. Vertical saccades.

- Eyes moving rapidly between two targets
  - Do not move head, move eyes
  - 3 ft from patient
- Horizontal
  - 30 degrees to left and right
  - 10 reps
- Vertical
  - 30 degrees up and down
  - 10 reps

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VOMS – Near Point Convergence

- View target without double vision
- Focus on small target (14pt font)
  - Hold at arm's length & slowly bring toward nose
  - Stop when double vision or when examiner notices outward deviation of eye
- 3 reps, record distance in cm
  - 6+ cm is abnormal

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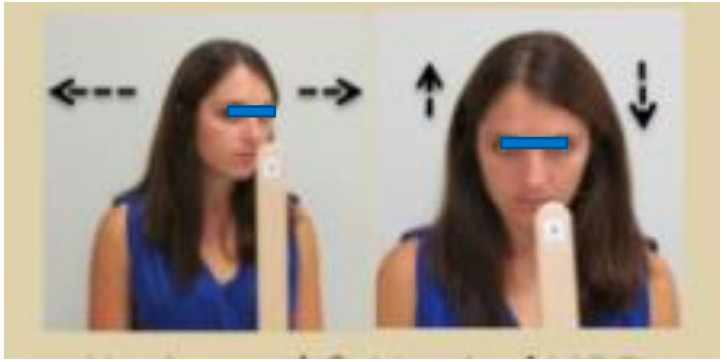
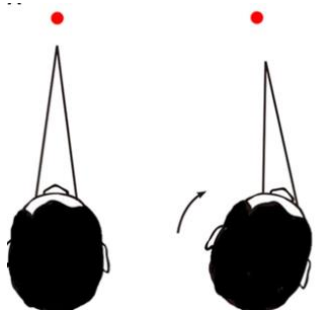
VOMS – Vestibular Ocular Reflex (VOR)

- Stabilize vision as head moves
- Hold 14 pt font sized target 3 feet in front of patient
- Horizontal
  - Rotate head 20 degrees in each direction
  - 180 bpm for direction change
  - 10 reps (both R and L)
- Vertical
  - Same, but up and down





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VOMS – Visual Motion Sensitivity (VMS)

- Ability to inhibit vestibular-induced eye movements with vision
- Feet shoulder width apart facing “busy” wall or part of clinic
- Arms outstretched in front and focus on thumb
  - Rotate trunk 80 degrees left and right
  - Keep focus on thumb
  - 50 bpm (per direction)
  - 5 reps (start – L – R – back to start)

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Neuroimaging - CT

- In the hours after an injury (CT scan if <6h, but reality is more like <48h):
  - Worsening symptoms
  - Declining mental status
  - Focal neurologic deficits
  - Concern for skull fracture

- PECARN Data (Kupperman et al. 2009 Lancet)
  - GCS <15, signs of basilar skull fx, or altered mental status – Get CT
  - GCS 15 but with LOC, emesis, severe HA, severe MOI
    - Strongly consider CT, as 1% risk of structural brain injury
  - Remainder of patients (about 58% total) – no CT because risk of structural brain injury was <0.05%

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Neuroimaging - MRI

- Later (MRI): (0.5% pediatric patients with persistent symptoms had findings compatible with traumatic injury)
  - Lack of improvement
  - Worsening symptoms
  - Concern for other intracranial pathology (ex: tumor, Chiari)

- Other imaging modalities (ex: PET, fMRI, MRS) are all for research purposes with no clinical utility at this time

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Office – Future Topics

- Computerized Neurocognitive Testing?
- Abbreviated Neuropsychological Evaluation?
- Prolonged recovery?
- Treatment
- Prevention
- Retirement

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THANK YOU!

Further reading…

- Halstead ME, Walter KD, Moffatt K. Sport-related concussion in children and adolescents. Pediatrics, 2018
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