



# **Comprehensive Evaluation, Management and Treatment of Mild Traumatic Brain Injury**

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# Definition of MTBI

- A complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces including:
  - Direct blow to body or head
  - Rapid onset of short lived impairment of neurological function that usually resolves spontaneously
  - Traditional imaging (CT and MRI 1.5T) tests usually normal
  - May or may not involve LOC



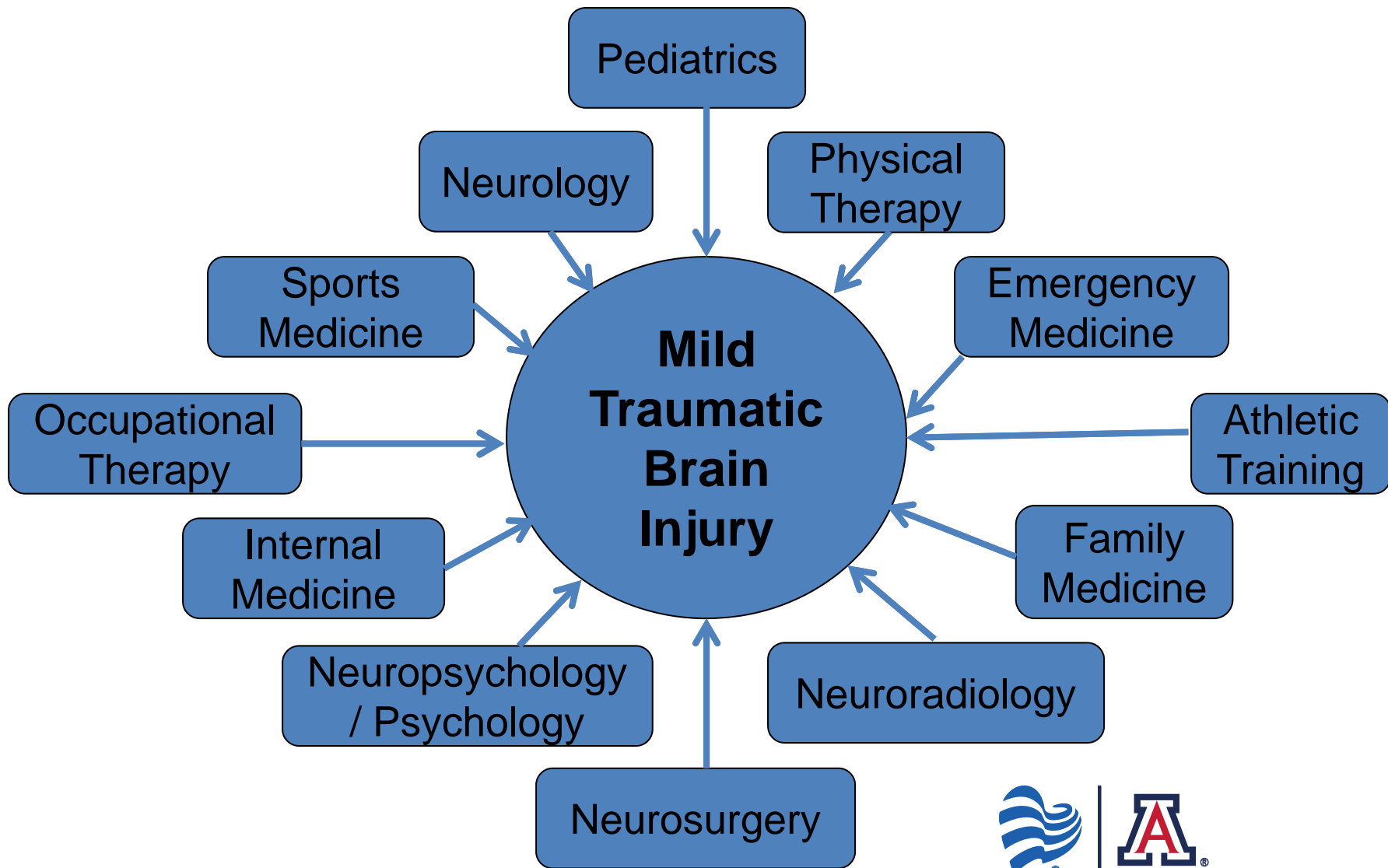
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# Definition of MTBI

<b>Criteria</b>	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
Structural imaging	Normal	Normal or abnormal	Normal or abnormal
Loss of Consciousness (LOC)	0–30 min	> 30 min and < 24 hrs	> 24 hrs
Alteration of consciousness/mental state (AOC) *	Transient up to 24 hrs	> 24 hours. Severity based on other criteria	
Post-traumatic amnesia (PTA)	0–1 day	> 1 and < 7 days	> 7 days
Glascow Coma Scale (best available score in first 24 hours)	13-15	9-12	< 9



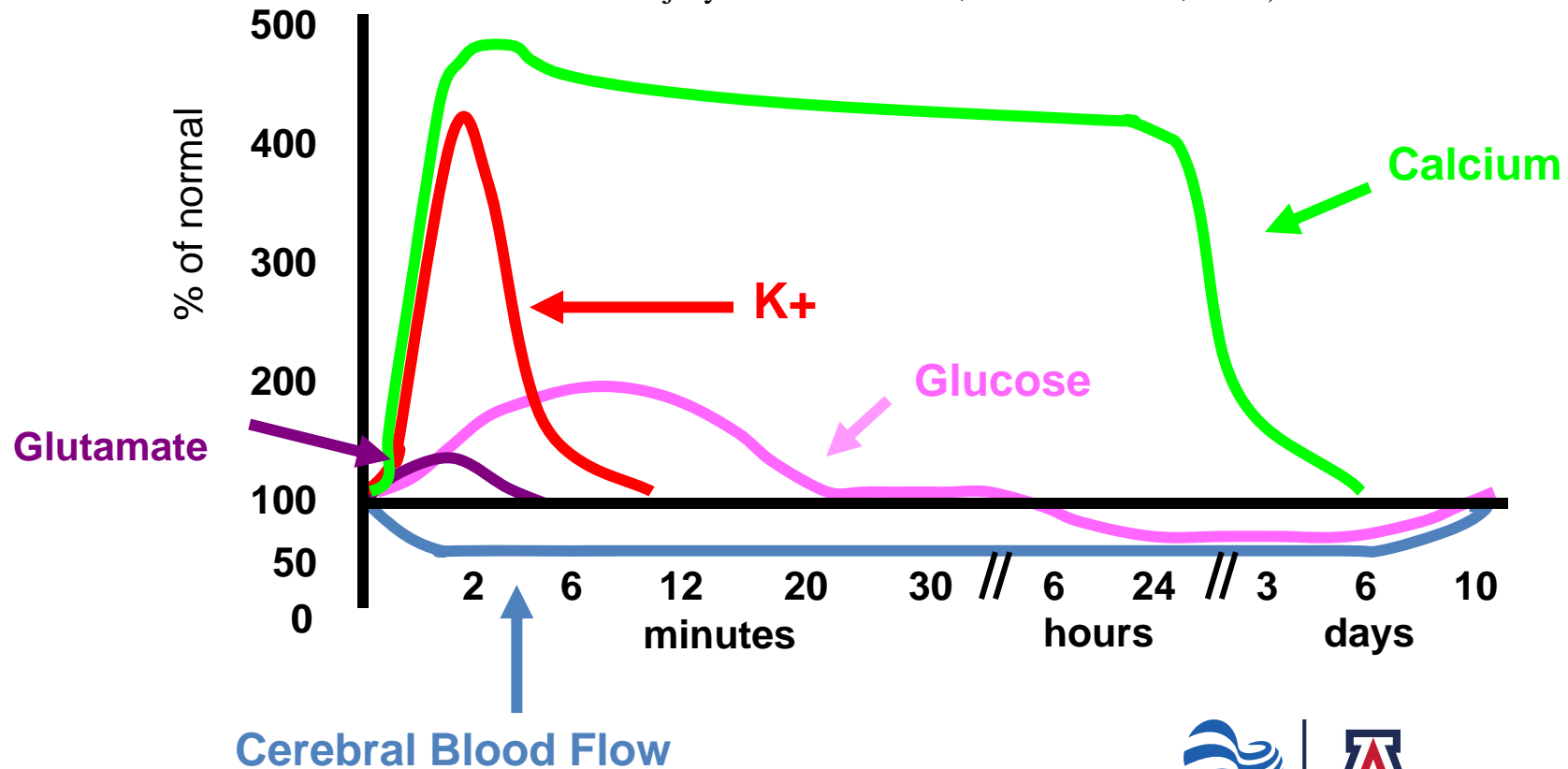
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# Neurometabolic Cascade Following Cerebral Concussion

UCLA Brain Injury Research Center, Giza & Hovda, 2001)



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# Incidence of Sports Related MTBI

- Estimated 3.8 million sports and recreational related concussions per year
- Collegiate football
  - Players 34% with one concussion, 20% with multiple concussions
  - Individual Risk 19%/year of play in contact sports
  - One concussion per team per three games
- High risk with soccer and cheerleading



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# Return to Play after MTBI

- Athletes should not be returned to play until their ALL of their neurologic function has returned to their usual state of health!
- “Get your mind right!!”



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# Symptoms of MTBI

- Headache, pressure in head
- Neck pain
- Nausea, Vomiting
- Dizziness
- Balance problems
- Vision changes, double, blurry
- Photosensitivity
- Phonosensitivity
- Feeling slowed down or in just “not right”
- Feeling sluggish or fatigued
- Confusion
- Feeling foggy
- Difficulty remembering
- Difficulty concentrating
- Irritability
- More emotional, nervous or sadness than usual
- Tinnitus



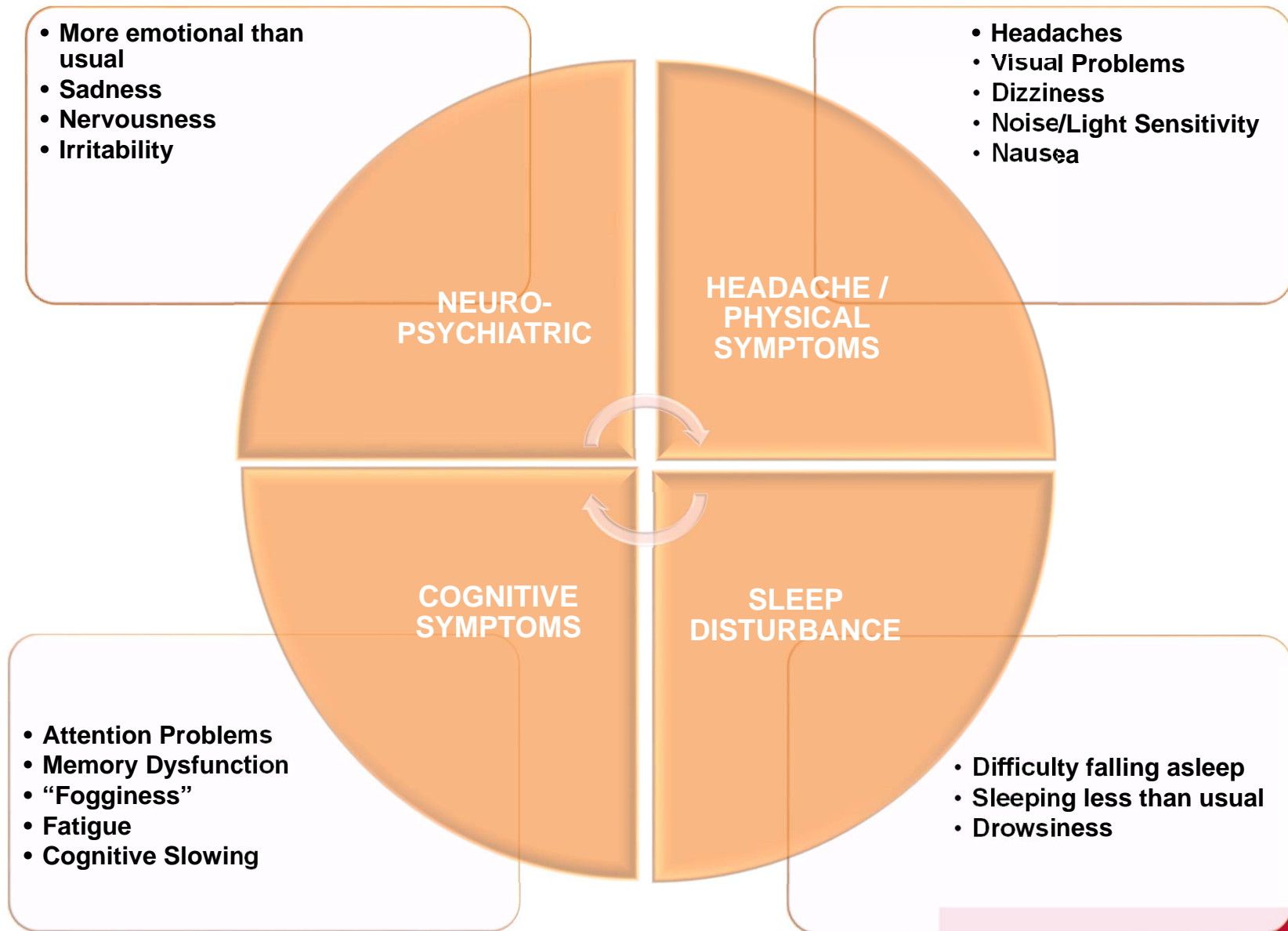
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# Factor Analysis

## Post-Concussion ImPACT Symptom Scale





# History and Physical

- Essential to perform a complete history and physical which identifies ALL of the deficits
- Don't just ask the concussed individual if their symptoms are gone and they are back to themselves



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# Neurologic Exam

- Non-focal complete neurologic exam
- Ocular / Vestibular Exam
  - Presence of nystagmus on pursuit testing
  - Horizontal and Vertical Saccadic Eye Movements - Dizziness or headache with saccade testing (rapidly move gaze back and forth between two objects)
  - Dizziness or headache with vestibular ocular reflex (VOR) (focus on an object while moving head side to side) is one of the most consistent physical exam findings in MTBI
  - Normal near point convergence



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# Visual Examination

- Pupillary exam (Hippus Response?)
- Static visual acuity
- Dynamic visual acuity
- Saccadic eye movements
- Near point convergence



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# Horizontal Saccadic Eye Movements



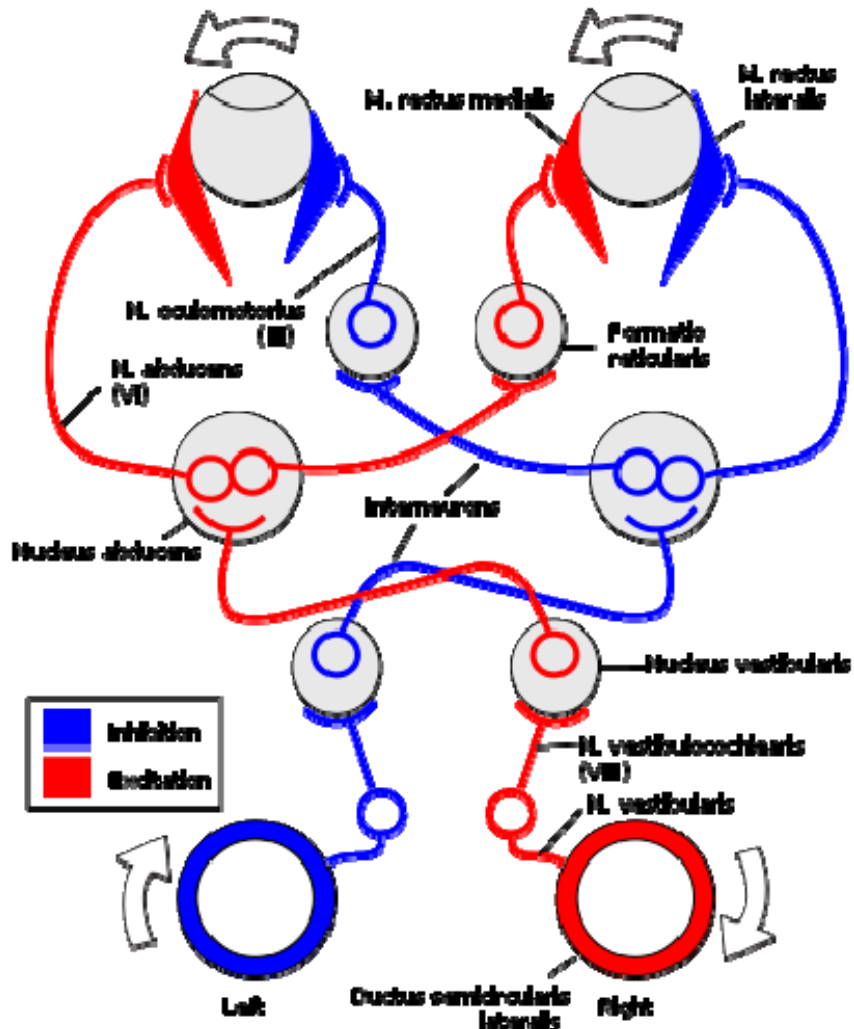
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# Vertical Saccadic Eye Movements



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# Vestibular Ocular Reflex



- The vestibulo-ocular reflex (VOR) is a brainstem level eye movement reflex which is triggered during head movement and produces eye movement in the direction opposite to head movement, thus preserving the image on the center of the visual field.



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# Horizontal Vestibular Ocular Reflex



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# Vertical Vestibular Ocular Reflex



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# VOR Cancellation Test



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# Neurologic Exam

## Balance Testing

- Cerebellum
  - Rapid alternating movements, finger to nose
- Due to postural instability positive Romberg and VOR cancellation tests are two of the most consistent physical finding in MTBI
- Tandem Gait (Eyes open and closed)



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# Balance Testing for Vestibular Dysfunction

- Balance Error Scoring System
- (BESS)
- Bertec Essential force plate technology



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# Is the Diagnosis Correct and Complete?

- Mild Traumatic Brain Injury
- Subdural Hematoma
- Epidural Hematoma
- Anxiety/Conversion Disorder
- Tension Headache
- Migraine Headache
- Occipital Neuralgia
- Post concussive seizures vs. epilepsy
- Stroke
- Cranial Nerve Palsy



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# Indications for CT

- Age < 2 or >65
- LOC or Amnesia with
  - Severe Headache
  - Nausea, Vomiting
  - Progressing symptoms
  - On anticoagulants
  - Post Traumatic Seizure
  - Dangerous mechanism of injury
  - Drug / Alcohol Intoxication
  - Memory Deficits
  - Physical evidence of trauma above the clavicle
  - GCS less than 15
  - Focal neurologic deficit
  - Coagulopathy



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# Indications for imaging in MTBI?

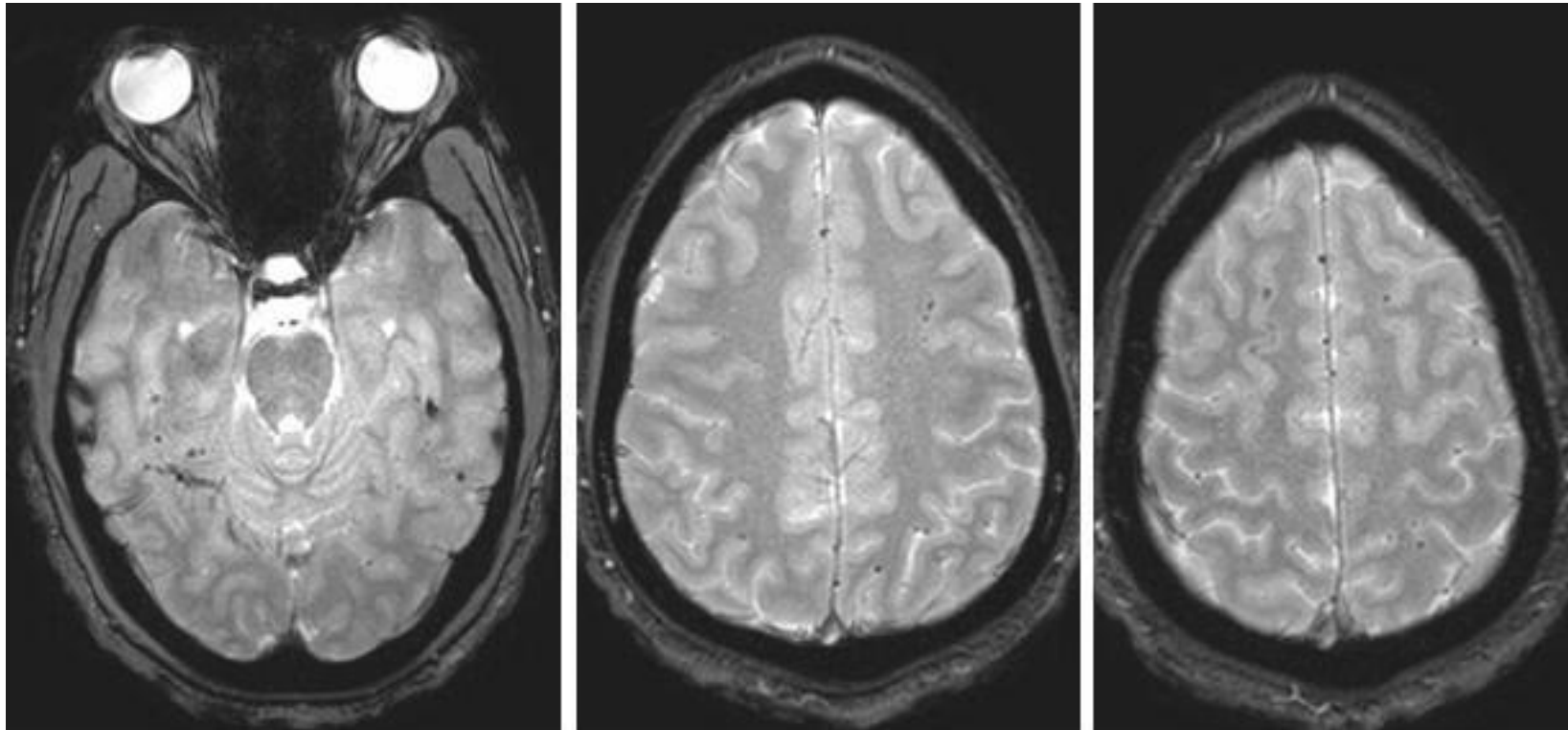
- CT Scan to rule out bleed?
- MRI (3T) may reveal subtle abnormalities
- Generally imaging is not indicated and will not assist in the management except to rule out other pathology



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# MRI Findings in MTBI



**Harmon, Drezner, O’Kane. Cerebral Microhemorrhages in a Collegiate Football Player: Clinical Implications in the Management of Sports Concussion.**



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# Cornerstone of MTBI Management

- Brain rest
  - No class
  - No physical exertion
  - No reading
  - No internet
  - No texting
  - No video games
  - Increase fluids / increase rest
  - TV?



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# Initial Treatment of MTBI

- Treatment of Headaches
- Treatment of Sleep Disturbance
- Treatment of Nausea
- Treatment of Dizziness



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# Normal Recovery Curves

- High School Students average recovery curve 14-21 days due to immaturity of the neurologic system (plasticity)
- College and Professional Athletes average recovery curve 7-10 days due to more mature neurologic system



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# Computerized Neurocognitive Screening

- Quantify the injury with a highly sensitive measure of brain function
- Protect the student athlete
- Help determine safe return to play
- Help prevent cumulative effects of multiple concussions
- Provides objective data to help determine athlete's injury status
- Prevent lingering effects of concussion and catastrophic injury.
- **Tool to assist clinical judgment !!!!**



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## ImPACT Quick Reference Reliable Change Estimates: 80% Confidence Interval

<u>Composite</u>	<u>Change</u>	<u>Optimal</u>
Verbal Memory	8 points	> 90
Visual Memory	13.5 points	> 80
Reaction Time	0.06 s	< 0.55
Processing Speed	5 points	40
Impulse Control	3 points	< 8
Symptom Score	10 points	0



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# Post Concussion Cognitive Dysfunction

- Computerized Neurocognitive Screening
- Formal Neuropsychological Testing
- Treatment:
  - Computerized Cognitive Rehab
  - Occupational Therapy
  - Speech Therapy



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# Post Concussive Vestibular Dysfunction

- More common in athletes where dizziness or fogginess is a primary presenting symptom
- Significantly abnormal VOR, saccadic eye movements and Romberg at presentation
- Benefit from early referral to vestibular therapist with experience in rehab of post concussive vestibular dysfunction



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# Post Concussion Syndrome

- Decreased Processing Speed
- Short-term Memory Impairment
- Concentration Deficit
- Irritability/Depression
- Fatigue/Sleep Disturbances
- General feeling of “fogginess”
- Persistent Symptoms >4 weeks after MTBI



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# Post Concussion Syndrome

- Post Traumatic Stress Disorder (PTSD)
- Anxiety
- Depression
- Adjustment Disorder



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# Post Concussion Syndrome

- Physical Therapy
- Occupational Therapy
- Vestibular Therapy
- Visual Therapy
- Cognitive Therapy
- Psychological Counseling



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# Multiple Concussions

- Following first episode of MTBI athlete is 4X more likely to experience another MTBI and 3X more likely to experience MTBI in the same season
- Concept of “Concussion Threshold”



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# Return to Play following multiple mTBIs

- How many concussions is too many concussions?



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# Persistent Cognitive Deficits

- 41% of 60+ year old retired NFL players had measurable cognitive impairment compared with normal controls
- 2/34 (6%) met diagnostic criteria for dementia
- Cognitive deficits correlated with white matter abnormalities and changes in regional cerebral blood flow
- 25% diagnosed with depression

Hart JJ, Kraut MA, JAMA Neurol 2013



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# Chronic Traumatic Encephalopathy (CTE)

- APOE4 gene associated with increased risk of Alzheimer's Disease
- APOE4 gene acts synergistically with head trauma to result in increased likelihood of Chronic Traumatic Encephalopathy (CTE) or dementia pugilistica
- May also influence recovery from acute MTBI



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# Return to School / Work

- Initially complete brain rest
- Gradual increase in activities as limited by symptoms
- Return to school depends on resolution of symptoms and neurocognitive testing
- Individualized return to school plan
- Coordination with school counselors and disability resource specialists



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# Return to Play Protocol

## Stepwise Protocol:

1. No activity, complete rest. Once asymptomatic, proceed to next level.
2. Light aerobic exercise such as walking or stationary cycling, no resistance training.
3. Sport specific exercise
4. Non-contact training drills
5. Full contact training after medical clearance.
6. Game play.



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# Summary

- Asymptomatic at rest
- Asymptomatic with cognitive exertion (has returned to being a student)
- Asymptomatic with physical exertion (has completed gradual physical progression)
- Normal imaging if done
- ALL neurofunctional testing has returned to baseline or normal expected range



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