Barrow Neurological Institute | Brain Injury & Sports Neurology Center

Let's Play Ball:
Recognizing and Managing Concussions in Youth & Adolescent Athletes

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Brain Injury and Sports Neurology Center
Barrow Neurological Institute

OBJECTIVES

1. **What is a concussion?**
   Pathophysiology of a concussion.

2. **Recognize**
   Describe the symptoms and signs of a concussion.

3. **Recommendations**
   Discuss the recommendations regarding anticipatory guidance, return to learn and play.

4. **Referral**
   Discuss when to refer an athlete to a specialist.

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Recommendations

- Outpatient clinic setting
- Mild traumatic brain injury without any intracranial abnormalities
- Not for sideline, emergency or inpatient settings.

SPORTS-R
CONCEPTU

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Consensus statement

Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport–Amsterdam, October 2022

Jon S Patricios [1], Kathryn J Schneider [2], Jiri Dvorak [3], Osman Hassan Ahmed [4,5], Cheri Blauwet [6,7], Robert C Cantu, [8,9] Gavin A Davis [10,11], Ruben J Echemendia [12,13], Michael Makdissi, [14,15] Michael McNamee, [16,17] Steven Broglio [18], Carolyn A Emery [2], Nina Feddermann-Demont, [19,20] Gordon Ward Fuller [21], Christopher C Giza, [22,23] Kevin M Guskiewicz, [24] Brian Hainline [25], Grant L Iverson [26,27], Jeffrey S Kutcher, [28] John J Leddy [29], David Maddocks, [30] Geoff Manley [31], Michael McCrea [32], Laura K Purcell, [33] Margot Putukian [34], Haruhiko Sato [35], Markku P Tuominen, [36] Michael Turner [37,38], Keith Owen Yeates [39], Stanley A Herring, [40,41] Willem Meeuwisse [42]

Patricios, J. S., Schneider, K. J., Dvorak, J., Ahmed, O. H., Blauwet, C., Cantu, R. C., Davis, G. A., Echemendia, R. J., Makdissi, M., McNamee, M., Broglio, S., Emery, C. A., Feddermann-Demont, N., Fuller, G. W., Giza, C. C., Guskiewicz, K. M., Hainline, B., Iverson, G. L., Kutcher, J. S., … Meeuwisse, W. (2023). Consensus statement on concussion in sport: The 6th International Conference on Concussion in sport–Amsterdam, October 2022. *British Journal of Sports Medicine*, *57*(11), 695–711. https://doi.org/10.1136/bjsports-2023-106898

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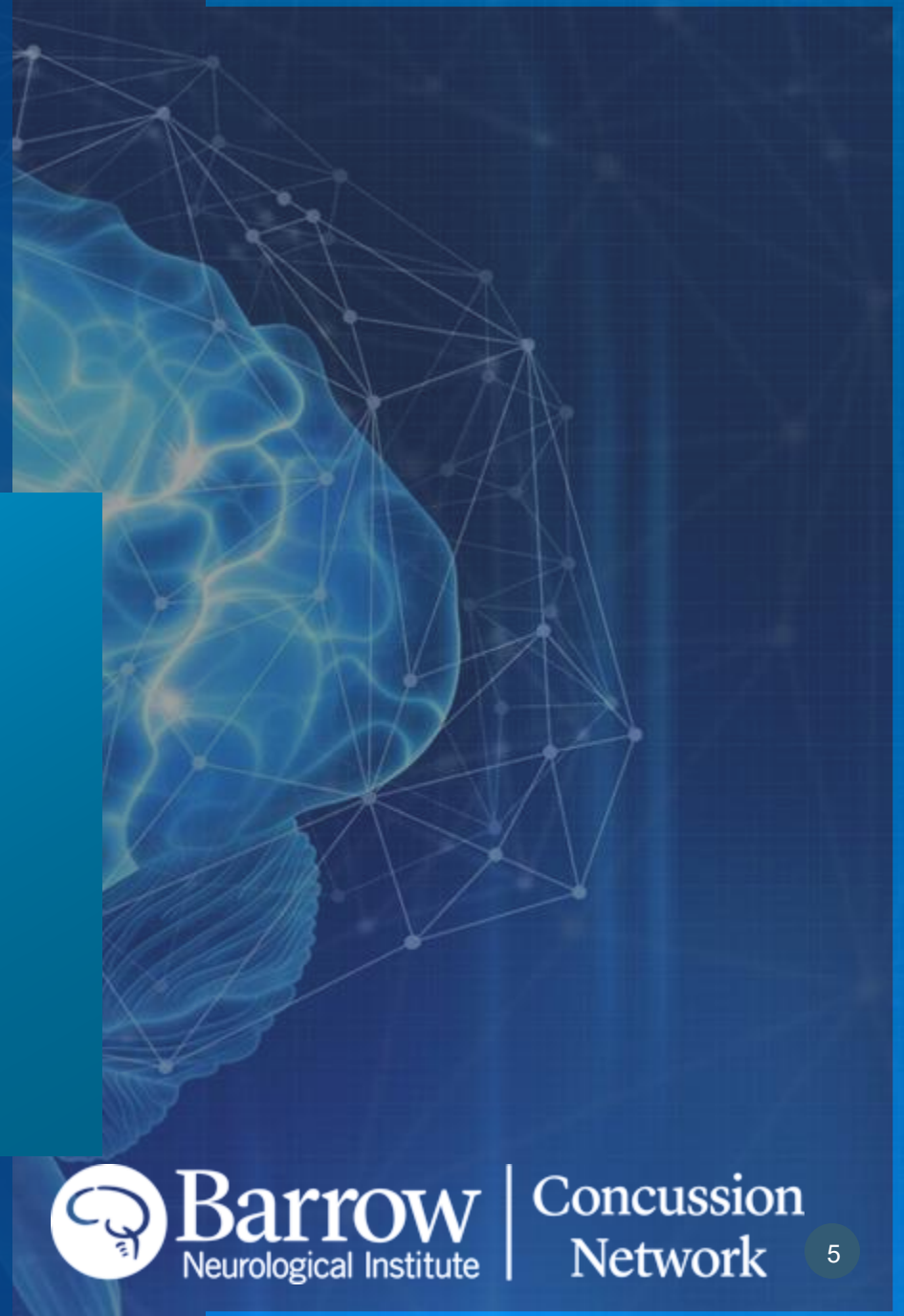
What is the diagnostic criteria?

The conceptual definition does not provide specific diagnostic criteria for SRC.



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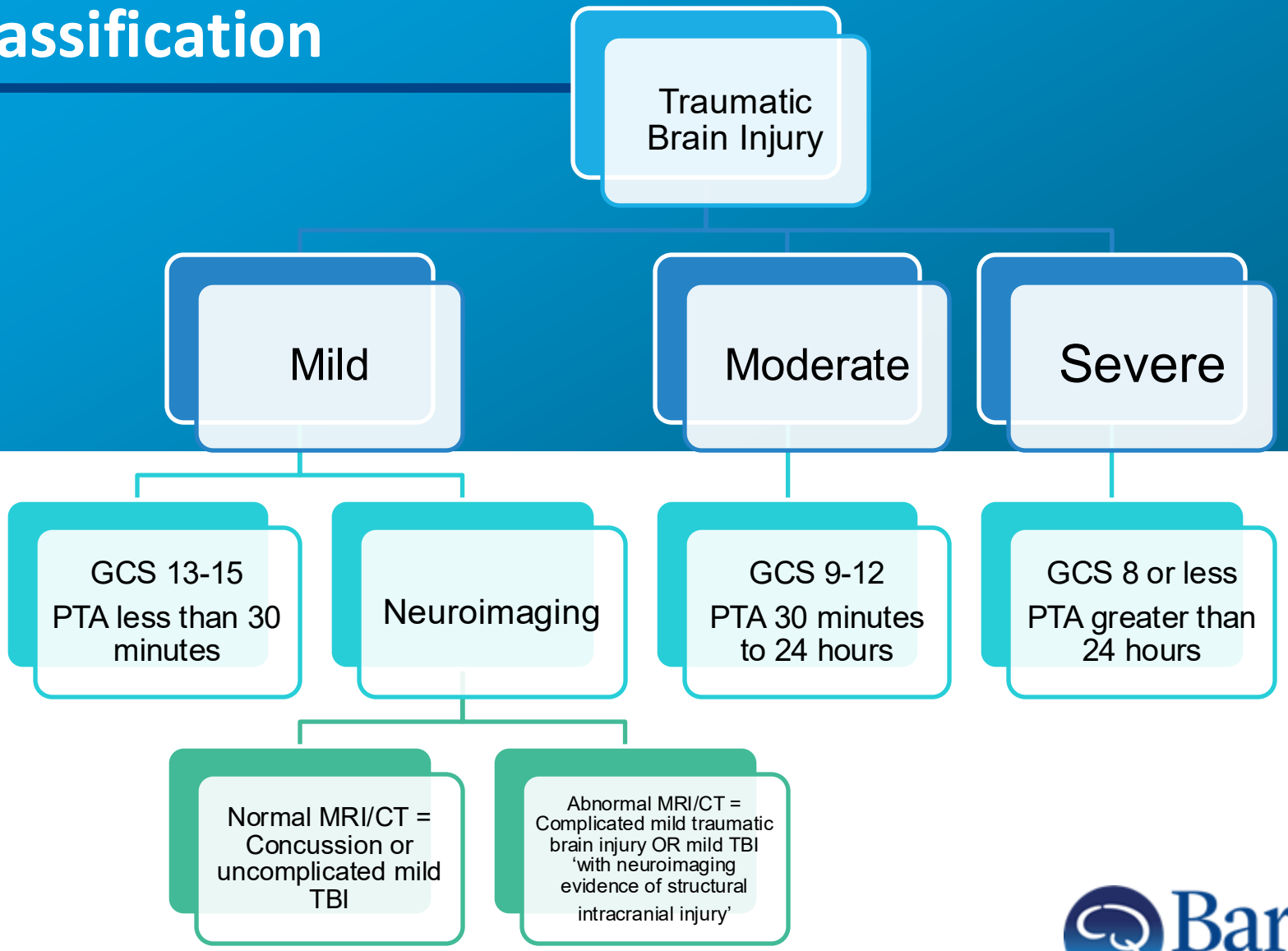
TBI Classification



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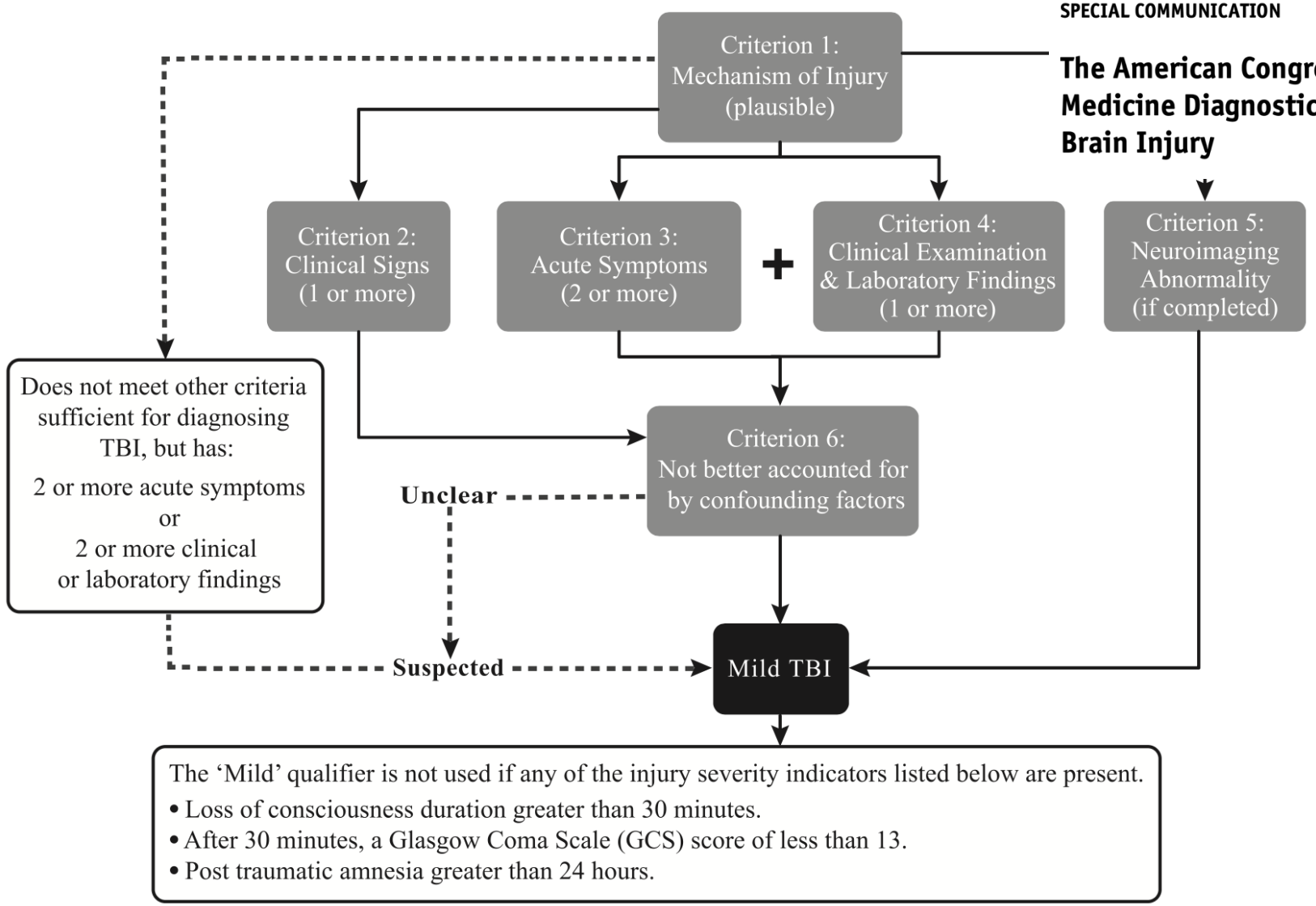
DIAGNOSTIC CRITERIA

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation
journal homepage: www.archives-pmr.org
Archives of Physical Medicine and Rehabilitation 2023;104: 1343–55

SPECIAL COMMUNICATION

The American Congress of Rehabilitation Medicine Diagnostic Criteria for Mild Traumatic Brain Injury



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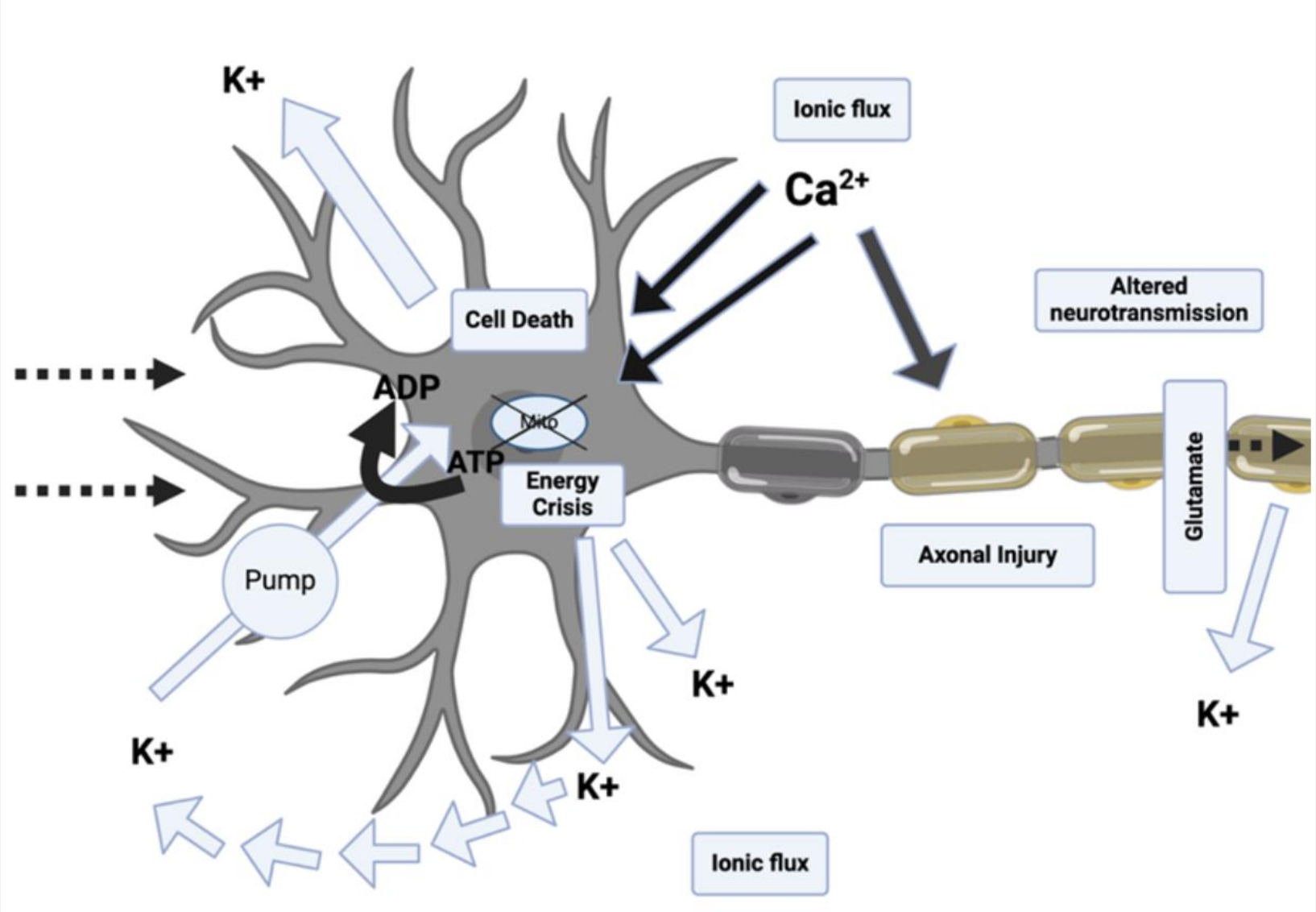
Pathophysiology



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SIGNS AND SYMPTOMS

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SIGNS OF A CONCUSSION: What you observe

PHYSICAL

- Slow to rise
- Clutching head
- Shaking it off
- Difficulties with motor coordination
- Fencing posture
- Loss of consciousness

COGNITIVE

- Dazed and stunned
- Blank look
- Answering questions slowly or inappropriately
- Repeating questions
- Cannot recall events around head injury

EMOTIONAL

- Aggressive
- Agitated
- More emotional
- Irritated

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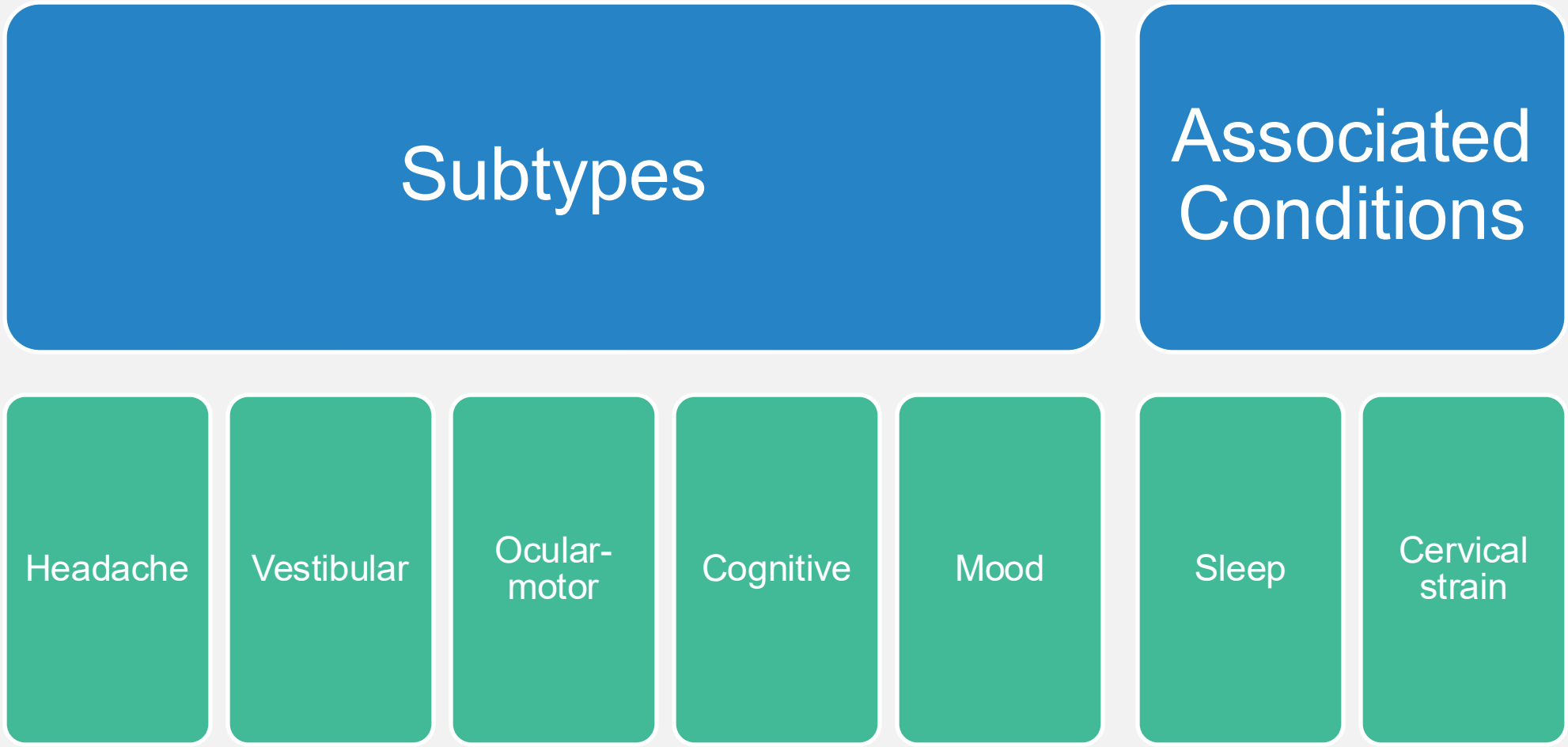
SYMPTOMS OF A CONCUSSION: What you feel

PHYSICAL	COGNITIVE	EMOTIONAL	SLEEP
Headache	Difficulty concentrating	Aggressive	Drowsiness
Dizziness/balance issues	Feeling "in a fog"	Agitated	Sleeping too much
Vision change	Decreased processing speed	More emotional	Sleeping too little
Light sensitivity	Difficulties multitasking	Irritated	Fatigue
Sound sensitivity	Memory issues		

Symptom Scales

- Postconcussion Symptom Scale (PCSS)
- Rivermead
- Graded Symptom Checklist
- Postconcussion Symptom Inventory (PCSI)
- Health and Behavior Inventory
- Acute Concussion Evaluation (ACE)

Concussion Symptom Subtypes



Lumba-Brown, Neurosurgery 2019

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RED FLAG SIGNS AND SYMPTOMS

Means something even WORSE than a concussion may be occurring

- Headache worsening
- Repeated vomiting
- Convulsions or seizures
- Inability to wake up
- Slurred speech
- Weakness or numbness
- Decreasing coordination
- Unusual behavior, increased confusion, combative

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Clinical Questions

Concussion diagnosis is made now what?

- Is this patient's symptom pattern consistent with a likely concussion?
- What is the patient's risk factors for a prolonged recovery?
- Is this patient at high risk for problems with academics or return to work?

RISK FACTORS FOR A PROLONGED RECOVERY

Severe symptom presentation right after injury

Clinical Action

- Record and track symptom severity

RISK FACTORS FOR A PROLONGED RECOVERY

History of concussion or intracranial injury

Clinical Action

- Inquire about prior head injuries
  - Mechanism
  - Time to recovery

RISK FACTORS FOR A PROLONGED RECOVERY

Personal history and family history

Clinical Action

- Assess extent and types of emotional and social support
- Prolonged recovery associated with
  - Older age: adolescents
  - Female sex
  - Lower cognitive abilities or learning difficulties
  - Neurological or psychiatric disorder
  - Increased pre-injury symptoms
  - Family and social stressors

Initial Physical Examination

Neurological Examination
- Mental status
- Balance
- Strength
- Scalp or skull abnormalities

Any signs of a cervical spine injury or deteriorating neurological function

Indications of cervical spine injury

- Weakness or numbness in upper and lower extremities
- Significant cervical pain with tenderness and/or loss of ROM

Signs of Neurological Deterioration

- Decreasing level of consciousness
- Any focal neurological deficit
- Increasing confusion
- Severe or worsening symptoms
- Increasing headaches
- Repeated vomiting
- Unusual behavior
- Seizures
- Slurred speech

To Radiate or Not?

CALIFORNIA ACEP
AMERICAN COLLEGE OF EMERGENCY PHYSICIANS

Choosing Wisely

A California ACEP/Choosing Wisely Collaboration

Pediatric Head Trauma CT Decision Guide

Children 2 years and older

2 YEARS & OLDER

- **GCS < 15**
- **Signs of basilar skull fracture**
- **AMS** (agitation, somnolence, slow response, repetitive questions)

YES TO ANY → CT

*High Risk – 4.3% risk of ci-TBI**

NO →

- **Vomiting**
- **LOC**
- **Severe headache**
- **Severe mechanism of injury**
  - Fall > 5 ft
  - MVA w/ejection, rollover, or fatality
  - Bike/ped vs. vehicle w/o helmet
  - Struck by high-impact object

NO → CT not indicated, **Observe**

Low Risk – < 0.05%

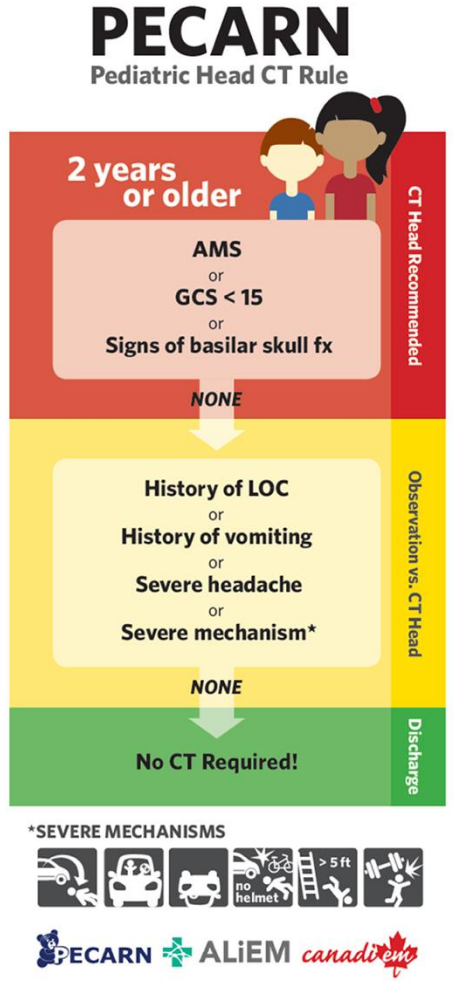
YES TO ANY → *Intermediate Risk – 0.8%*

Observation vs. CT using shared decision-making

Clinical factors used to guide decision-making:
- Multiple vs. isolated factors
- Worsening findings during observation (AMS, headache, vomiting)
- Physician experience
- Parental preference

*ci-TBI: risk of clinically important TBI needing acute intervention, based on PECARN validated prediction rules

Figure 2. PECARN Decision Rule for Patients Aged 2 to 18 Years



Abbreviations: AMS, altered mental status; CT, computed tomography; GCS, Glasgow Coma Scale; LOC, loss of consciousness; PECARN, Pediatric Emergency Care Applied Research Network.
Used with permission from Academic Life in Emergency Medicine.

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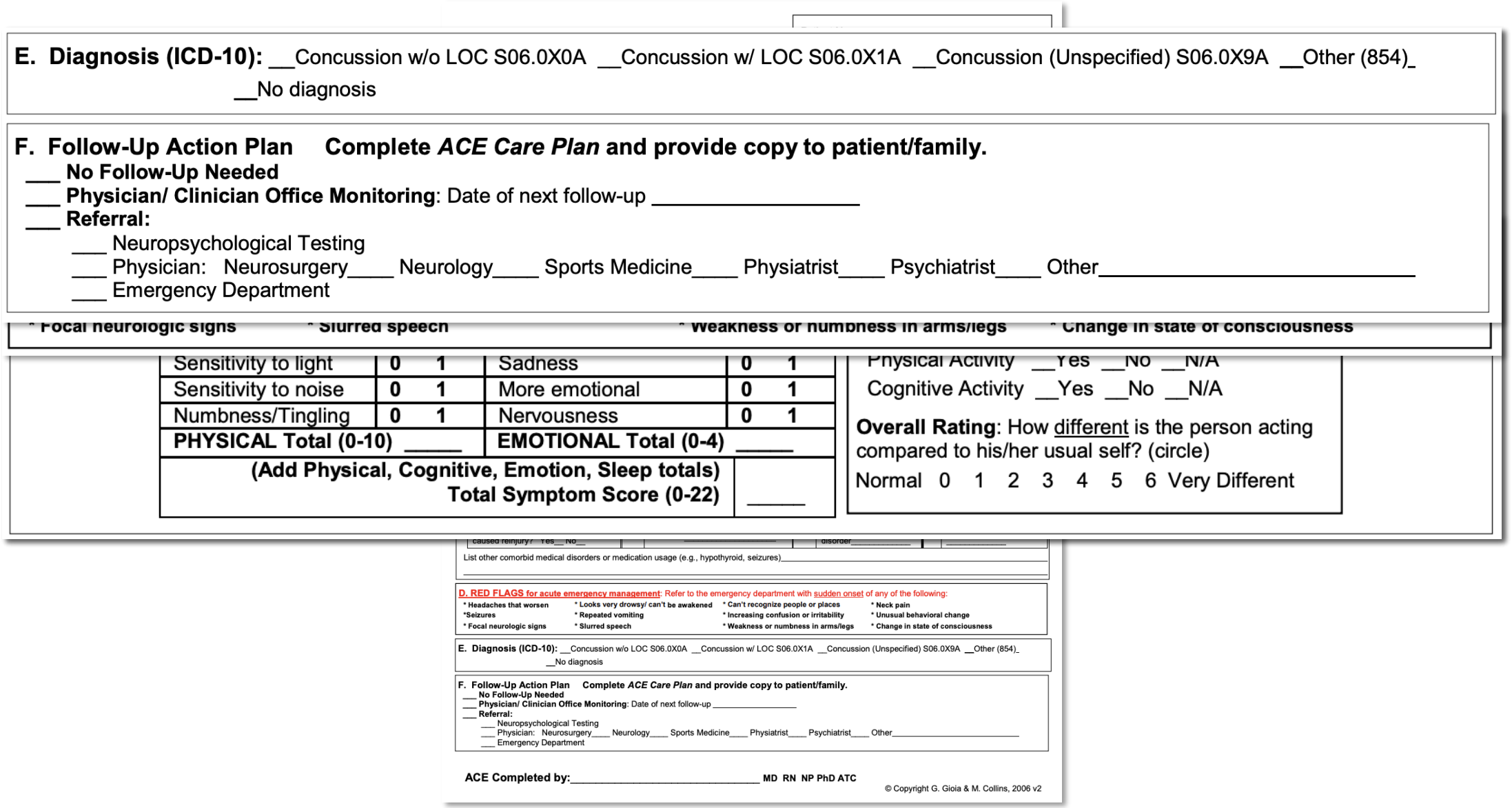
Following Your Clinical Assessment

- Likelihood of diagnosis
- Time to recovery
- Likelihood of prolonged/complicated recovery
- Need for pharmacological or rehabilitation treatment plan
- Return to school, necessary accommodations
- Return to physical activity, sports, recreation

Putting It All Together



E. Diagnosis (ICD-10): __Concussion w/o LOC S06.0X0A __Concussion w/ LOC S06.0X1A __Concussion (Unspecified) S06.0X9A __Other (854)_
__No diagnosis

F. Follow-Up Action Plan **Complete *ACE Care Plan* and provide copy to patient/family.**
___ **No Follow-Up Needed**
___ **Physician/ Clinician Office Monitoring**: Date of next follow-up _____
___ **Referral:**
___ Neuropsychological Testing
___ Physician: Neurosurgery____ Neurology____ Sports Medicine____ Physiatrist____ Psychiatrist____ Other_____
___ Emergency Department

*** Focal neurologic signs** *** Slurred speech** *** Weakness or numbness in arms/legs** *** Change in state of consciousness**

Sensitivity to light	0	1	Sadness	0	1
Sensitivity to noise	0	1	More emotional	0	1
Numbness/Tingling	0	1	Nervousness	0	1
PHYSICAL Total (0-10) _____			**EMOTIONAL Total (0-4)** _____		
(Add Physical, Cognitive, Emotion, Sleep totals) Total Symptom Score (0-22) _____					

Physical Activity __Yes __No __N/A
Cognitive Activity __Yes __No __N/A

Overall Rating: How different is the person acting compared to his/her usual self? (circle)
Normal 0 1 2 3 4 5 6 Very Different

List other comorbid medical disorders or medication usage (e.g., hypothyroid, seizures)_____

D. RED FLAGS for acute emergency management: Refer to the emergency department with sudden onset of any of the following:

* Headaches that worsen	* Looks very drowsy/ can't be awakened	* Can't recognize people or places	* Neck pain
*Seizures	* Repeated vomiting	* Increasing confusion or irritability	* Unusual behavioral change
* Focal neurologic signs	* Slurred speech	* Weakness or numbness in arms/legs	* Change in state of consciousness

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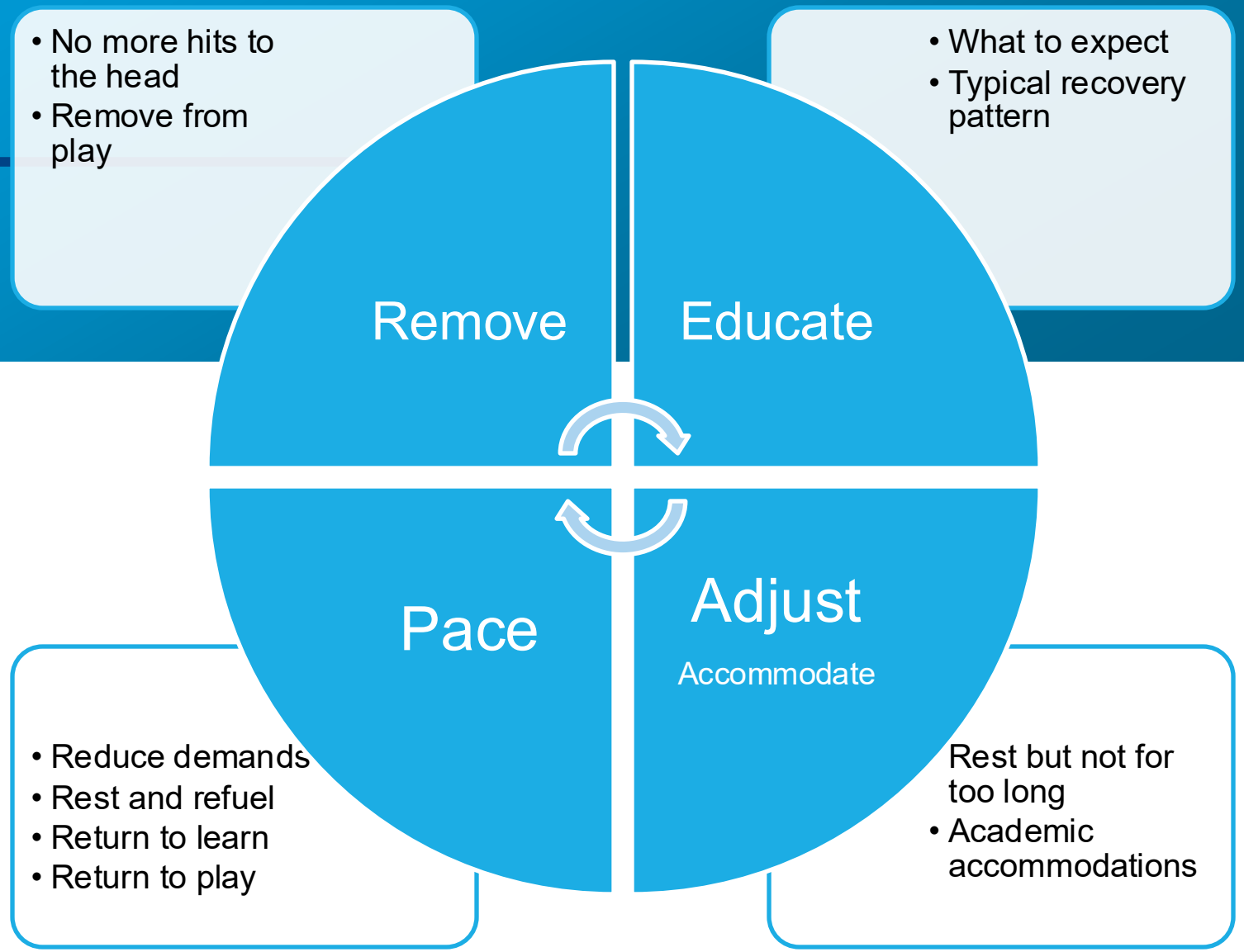
___ **Referral:**
___ Neuropsychological Testing
___ Physician: Neurosurgery____ Neurology____ Sports Medicine____ Physiatrist____ Psychiatrist____ Other_____
___ Emergency Department

ACE Completed by:_____ **MD RN NP PhD ATC**

Recovery Plan

No more “cocooning”



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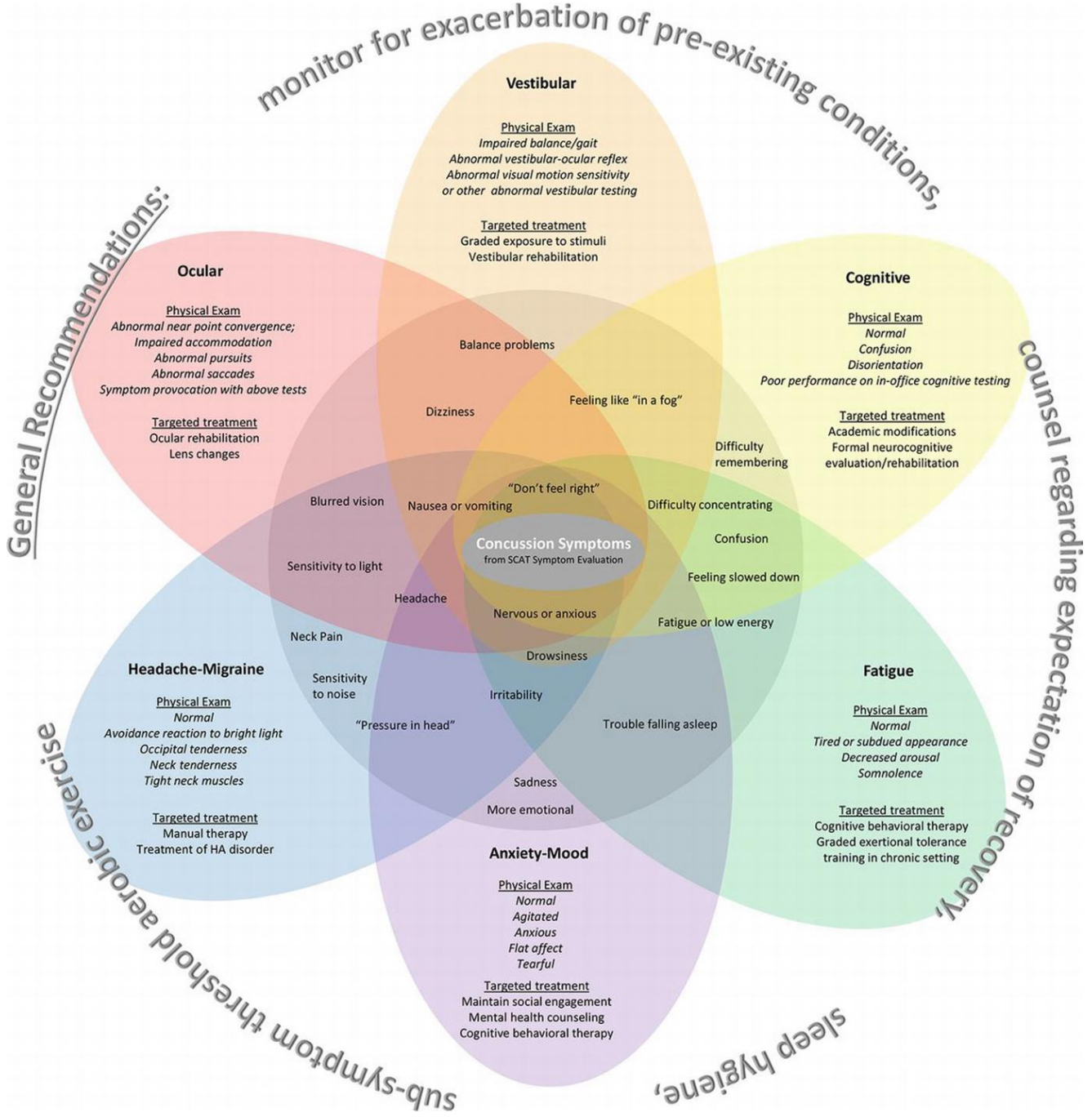
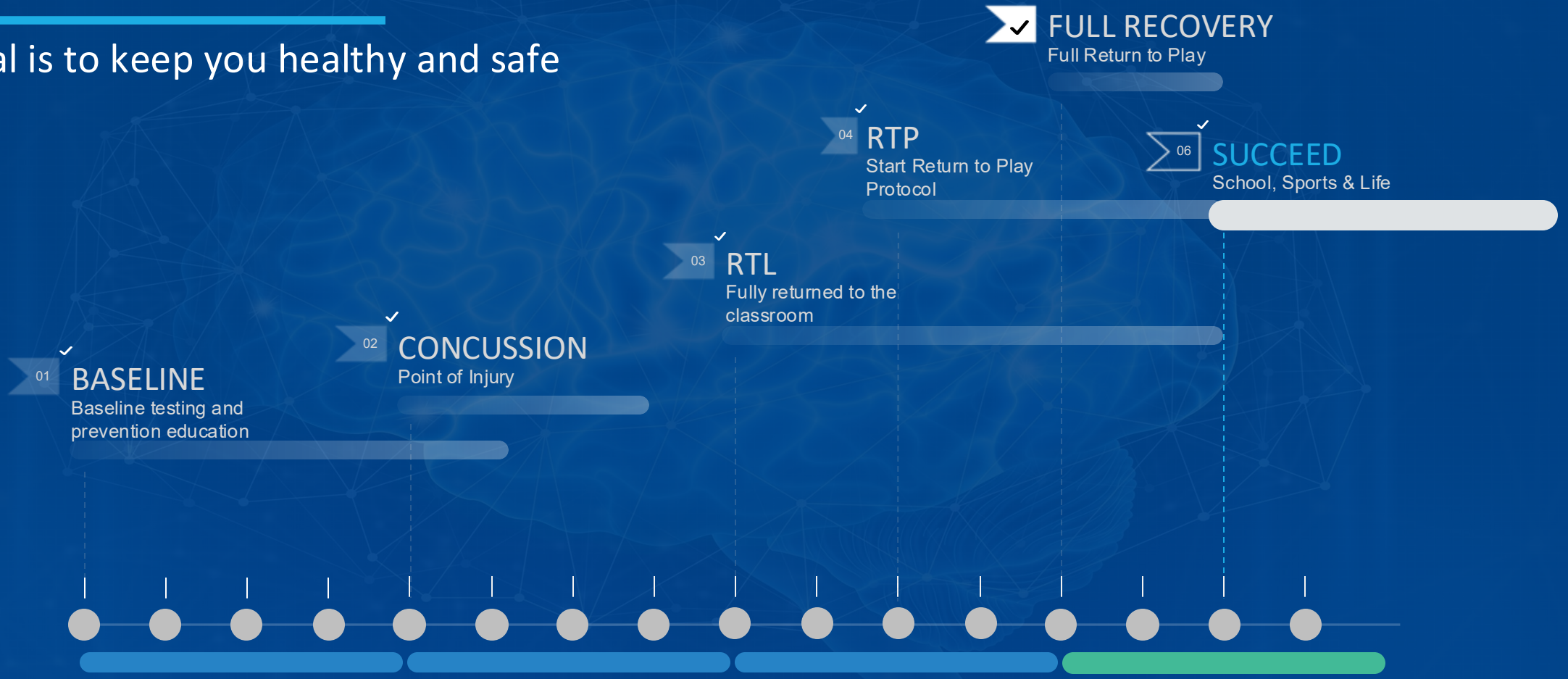
Overlapping Clinical Profiles



Harmon, K. G., Clugston, J. R., Dec, K., Hainline, B., Herring, S., Kane, S. F., Kontos, A. P., Leddy, J. J., McCrea, M., Poddar, S. K., Putukian, M., Wilson, J. C., & Roberts, W. O. (2019). American Medical Society for Sports Medicine Position Statement on Concussion in sport. *British Journal of Sports Medicine*, *53*(4), 213–225. https://doi.org/10.1136/bjsports-2018-100338

TIMELINE GOALS

Our goal is to keep you healthy and safe



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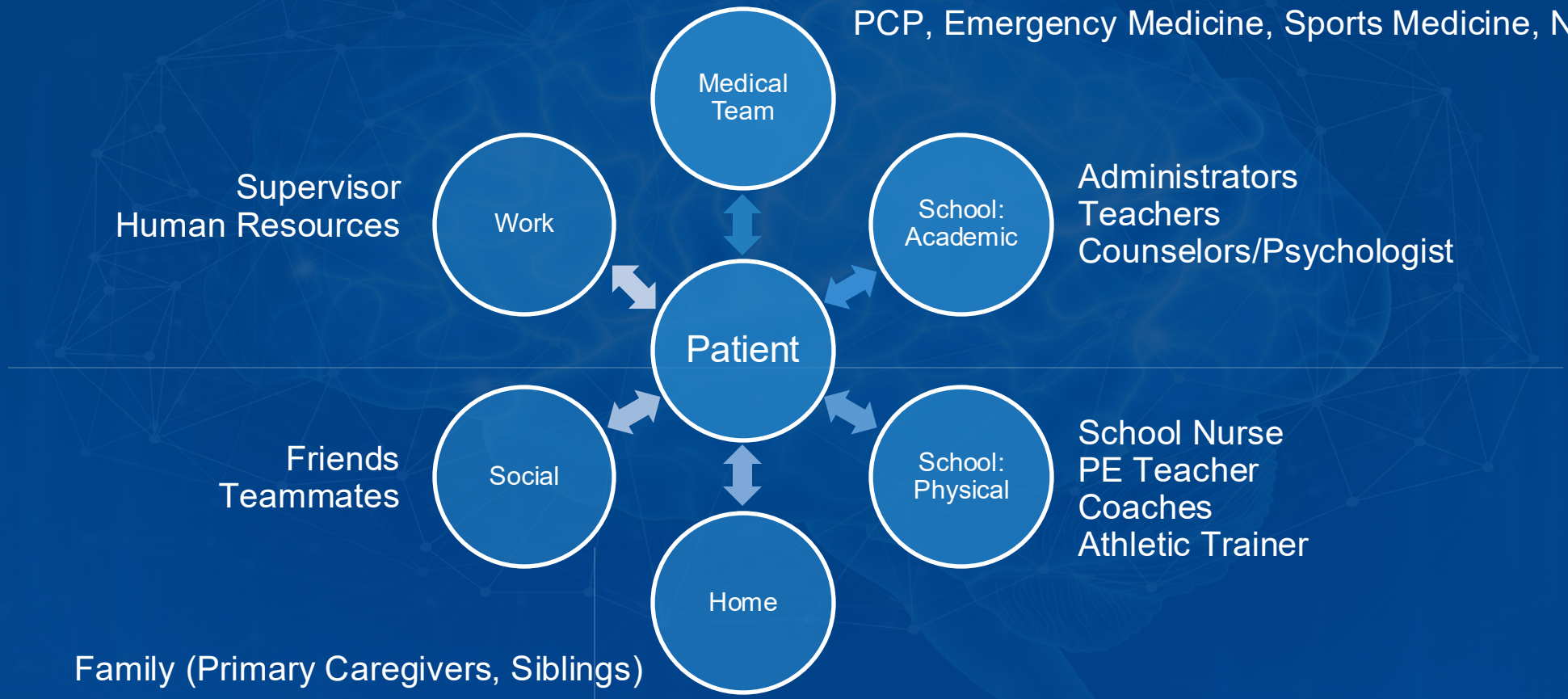
Concussion's Medical Neighborhood



REFERRAL TO A SPECIALIST

- Persisting symptoms
- Plateaued recovery
- Worsening symptoms
- Atypical symptoms
- Concerning exam
- Complicated history
- Need for specialized treatment
- Other neurological disorders

Christine Solis

Barrow Brain Injury & Sports Neurology Center Scheduling Coordinator
Referrals can be faxed to 602-406-3810

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MEET THE TEAM







- Brain Injury & Sports Neurology Center
  - Programs
    - Barrow Concussion Network
      - Second opinion portal for athletic trainer to submit e-consult to a concussion specialist
    - Domestic Violence
- Barrow Neurological Institute
  - Native American Health Equity Outreach Program

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Barrow Concussion Network

Prevention & Education

- Professional education
- Concussion research

Baseline Testing

- Baseline ImPACT testing

Post-Injury Care

- Concussion opinion portal
- Post-injury ImPACT testing
- Neurology consultation available

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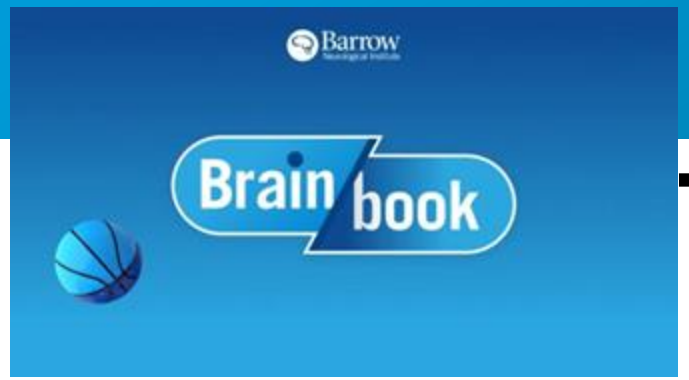

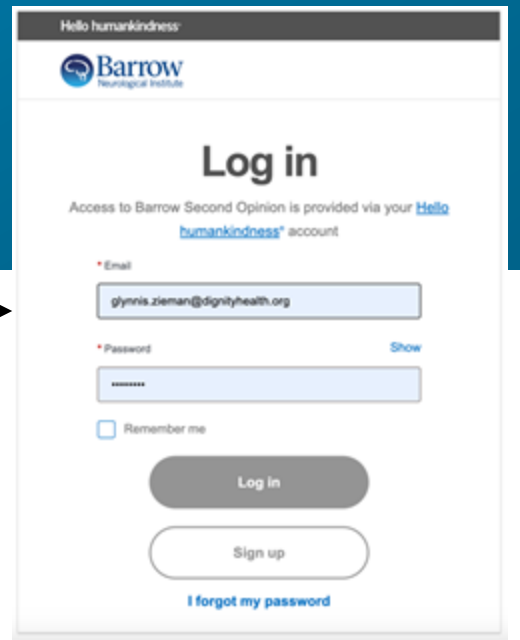

Baseline ImPACT®

Post-Injury ImPACT®

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Arizona Revised Statutes 15-341

- April 21, 2011
- 15th state to pass high school concussion law

ATC, MD, DO, NP, PA

- **Guidelines/education:** calls for school districts boards to develop concussion guidelines and educational programs.
- **Mandatory consent:** requires youth athletes and a parent and/or guardian sign and return a concussion and head injury information sheet on a yearly basis;
- **Immediate removal if concussion suspected.** Youth athletes suspected of having sustained a concussion in a practice, game or interscholastic activity must be immediately removed from competition. In addition to removal by coaches and licensed health care provider (doctor, athletic trainer, nurse practitioner, or physician assistant), game officials and *parents* are empowered to remove a player;
- **Same day return to play only if suspected concussion ruled out.** A player may return to play on the same day only if a health care provider rules out a suspected concussion at the time of removal.
- **Clearance before return to play.** Youth athletes who have been taken out of a game because of a suspected concussion are barred from same day return to play and will only be allowed to return to play on a subsequent day after:
  - **being evaluated** by a health care provider with specific training in the evaluation and management of concussions and head injuries,
  - **written clearance to return to play** from that health care provider.
- **Legal immunity:** A health provider who volunteers his or her services and provides written clearance to play is immune from civil liability for all decisions and actions taken in good faith implementation of the law except in cases of gross negligence or wanton or wilful neglect.
- **Apples to private organizations using school athletic facilities.** Any group or organization that uses property or facilities owned or operated by the school district for athletic activities must comply with the law.
- **Does not apply to all athletic activities:** Unlike some state laws, the Arizona law does not appy to dance or rythmic gymnastics.

Arizona Interscholastic Association
Constitution & Bylaws 2025-2026
Article 43: Sports Medicine

- 43.3 CONCUSSION EDUCATION – All student athletes shall complete the Brainbook online concussion education course. Student athletes participating in sports shall complete the course. All student-athletes shall complete the course prior to participation in practice or competition.

NOTE: The Brainbook online concussion education course must be completed by a student-athlete only once

Article 43

- 43.4.1 Education
  - 43.4.1.1 All AIA Participating schools must have a concussion policy on file: The policy must address the following: • Concussion Education • Removal from Play • Return to Play • Return to Academics
  - 43.4.1.2 Parents and athletes must sign a form acknowledging education regarding concussion.
- 43.4.2 Mechanics and Criteria for Removal from Play
  - 43.4.2.1 An athlete, coach, licensed athletic trainer, team physician, official or parent can remove an athlete from play.
  - 43.4.2.2 Only an appropriate health care professional can refute the diagnosis of a concussion.

Article 41

- 43.4.3 Return to Play Criteria
  - No athlete should return to play (RTP) or practice on the same day of a concussion.
  - Any athlete suspected of having a concussion should be evaluated by an appropriate health-care professional that day.
  - Any athlete with a concussion should be medically cleared by an appropriate health-care professional prior to resuming participation in any practice or competition.
  - After medical clearance, return to play shall follow a step-wise protocol with provisions for delayed return to play based as directed by an appropriate health-care professional.
  - Return to play should only occur after an athlete has returned to full school attendance without academic accommodations.
- 43.4.4 Appropriate Health-Care Professionals for Return to Play An appropriate health-care professional is defined as the following:
  - Licensed Athletic Trainer
  - Physician (MD/DO)
  - Licensed Nurse Practitioner
  - Physician's Assistant

Article 41

- 43.4.5 Return to Academics
  - Cognitive rest, including reduced screen time, may be recommended for the first 24-48 hours.
  - Student-athletes can engage in sub-symptom cognitive activities as tolerated.
  - Cognitive exertions should be stopped if concussion symptoms exacerbation is more than mild and brief and may be resumed once symptoms have returned to their prior level. Mild symptom exacerbation is typically brief and does not delay recovery.
  - Schools should have policies to facilitate academic support, especially those that address factors that may prolong return to the classroom (e.g. High symptom burden, social determinants of health).
  - Not all student-athletes will need academic support or a return to learn strategy.
  - While return to learn and return to sport strategies can occur in parallel, student athletes should complete return to learn before unrestricted return to sport.
  - Returning an athlete to the classroom following a concussion should follow a return to learn progression.

Article 41

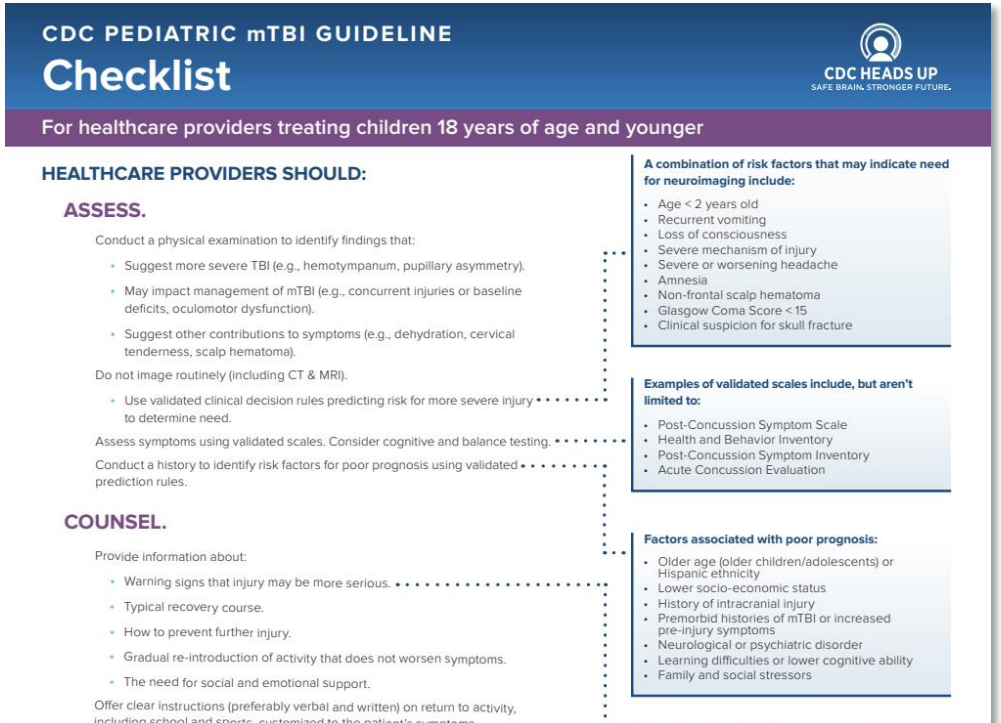
- 43.4.6 Other
  - 43.4.6.1 At the beginning of a game, the coach must certify to the official that the equipment is in compliance with safety regulations and properly fitted.
  - 43.4.6.2 If a helmet comes off or becomes dislodged during play, must remain out for one play or call a time out to have the equipment reassessed.

Resources

- HEADS UP to Healthcare Providers
  - Training for clinicians, school health providers, and other allied health professionals

Resources

- HEADS UP to Healthcare Providers
  - Tools for Providers
    - Mild Traumatic Brain Injury Guidelines for adult and pediatrics
    - ACE forms
    - Standardized letter for school accommodations



CDC PEDIATRIC mTBI GUIDELINE

Checklist

CDC HEADS UP
SAFE BRAIN. STRONGER FUTURE.

For healthcare providers treating children 18 years of age and younger

HEALTHCARE PROVIDERS SHOULD:

ASSESS.

Conduct a physical examination to identify findings that:

- Suggest more severe TBI (e.g., hemotympanum, pupillary asymmetry).
- May impact management of mTBI (e.g., concurrent injuries or baseline deficits, oculomotor dysfunction).
- Suggest other contributions to symptoms (e.g., dehydration, cervical tenderness, scalp hematoma).

Do not image routinely (including CT & MRI).

- Use validated clinical decision rules predicting risk for more severe injury to determine need.

Assess symptoms using validated scales. Consider cognitive and balance testing.

Conduct a history to identify risk factors for poor prognosis using validated prediction rules.

COUNSEL.

Provide information about:

- Warning signs that injury may be more serious.
- Typical recovery course.
- How to prevent further injury.
- Gradual re-introduction of activity that does not worsen symptoms.
- The need for social and emotional support.

Offer clear instructions (preferably verbal and written) on return to activity, including school and sports, customized to the patient's symptoms.

A combination of risk factors that may indicate need for neuroimaging include:

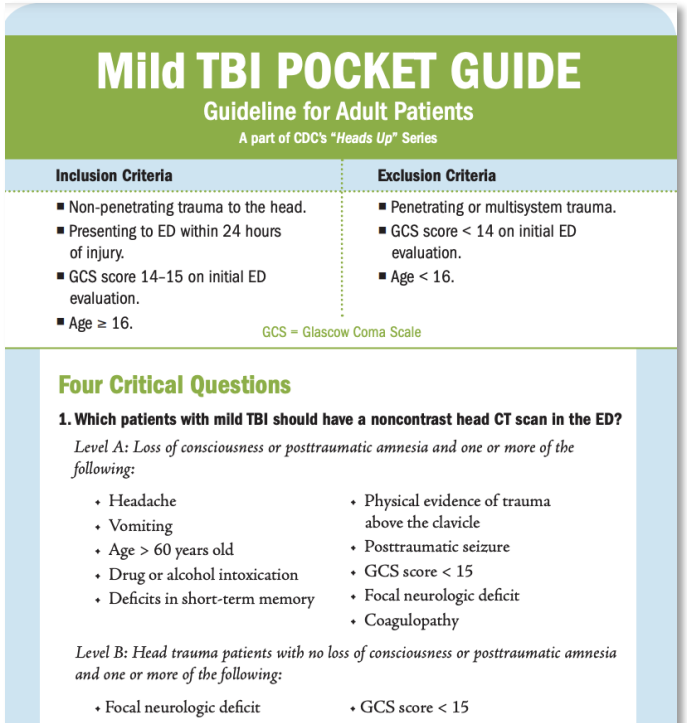
- Age < 2 years old
- Recurrent vomiting
- Loss of consciousness
- Severe mechanism of injury
- Severe or worsening headache
- Amnesia
- Non-frontal scalp hematoma
- Glasgow Coma Score < 15
- Clinical suspicion for skull fracture

Examples of validated scales include, but aren't limited to:

- Post-Concussion Symptom Scale
- Health and Behavior Inventory
- Post-Concussion Symptom Inventory
- Acute Concussion Evaluation

Factors associated with poor prognosis:

- Older age (older children/adolescents) or Hispanic ethnicity
- Lower socio-economic status
- History of intracranial injury
- Premorbid histories of mTBI or increased pre-injury symptoms
- Neurological or psychiatric disorder
- Learning difficulties or lower cognitive ability
- Family and social stressors



Mild TBI POCKET GUIDE

Guideline for Adult Patients

A part of CDC's "*Heads Up*" Series

Inclusion Criteria	Exclusion Criteria
■ Non-penetrating trauma to the head.	■ Penetrating or multisystem trauma.
■ Presenting to ED within 24 hours of injury.	■ GCS score < 14 on initial ED evaluation.
■ GCS score 14–15 on initial ED evaluation.	■ Age < 16.
■ Age ≥ 16.	

GCS = Glasgow Coma Scale

Four Critical Questions

1. Which patients with mild TBI should have a noncontrast head CT scan in the ED?

Level A: Loss of consciousness or posttraumatic amnesia and one or more of the following:

- Headache
- Vomiting
- Age > 60 years old
- Drug or alcohol intoxication
- Deficits in short-term memory
- Physical evidence of trauma above the clavicle
- Posttraumatic seizure
- GCS score < 15
- Focal neurologic deficit
- Coagulopathy

Level B: Head trauma patients with no loss of consciousness or posttraumatic amnesia and one or more of the following:

- Focal neurologic deficit
- GCS score < 15

KNOWLEDGE GAPS & ONGOING RESEARCH

Current Research Priorities

- Objective diagnostic biomarkers and tools
- Age-specific management protocols
- Predicting recovery trajectories
- Sex-based differences in injury and recovery
- Cumulative effects of sub-concussive impacts
- Optimal rehabilitation approaches
- Prevention strategy effectiveness

Promising Research Areas

- Blood biomarkers (GFAP, UCH-L1)
- Advanced neuroimaging (DTI, fMRI)
- Vestibular-ocular biomarkers
- Genetic factors in recovery
- Novel rehabilitation approaches
- Wearable impact sensors

KEY TAKEAWAYS

RECOGNITION

- Prompt identification and removal from play is critical

INDIVIDUALIZED MANAGEMENT

- Tailored approach based on symptoms, risk factors for a prolonged recovery

MULTIDISCIPLINARY CARE

- Coordination between medical providers, school personnel and sports staff

Referral to specialist, if needed

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THANK YOU

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