

Sports-Related Concussions:
A Guide to Diagnosis,
Management and Return to Play

Kristina Nivus, D.O.
Unity Health Care
The Wright Center for Graduate
Medical Education

Objectives

- Define concussion
- Identify the pathophysiology of concussion
- Recognize concussive symptoms
- Review epidemiology
- Sideline evaluation
- Management of concussion
- Return to play guidelines
- Return to learning guidelines

What Is A Concussion?

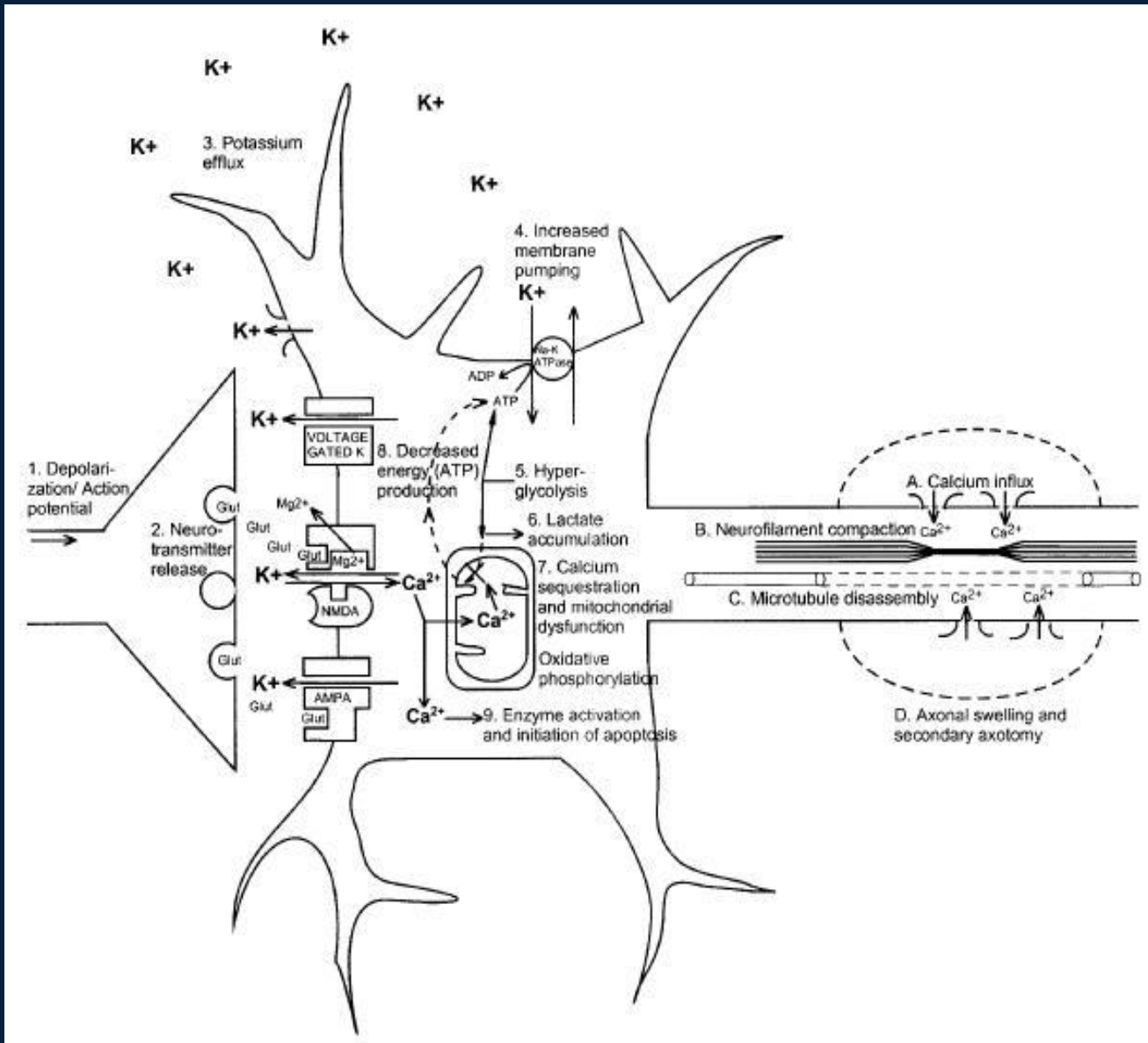
- Traumatically induced transient disturbance of brain function
- Clinical syndrome of biomechanically induced alteration of brain function, typically affecting memory and orientation
- Zurich Guidelines: “complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces”

Major Features

- Caused by direct blow to head or a blow that results in impulsive force transmitted to head
- Rapid onset of short-lived impairment of neurologic function
- Acute clinical symptoms reflect a functional disturbance rather than a structural injury
- Results in a graded set of clinical symptoms and resolution follows a sequential course
- May or may not involve loss of consciousness

Pathophysiology

- Acceleration-deceleration, rotational forces
- Animal models have been used to describe possible pathophysiologic mechanism
 - Unclear if it can be applied to sport-related concussion



Risk Factors & Modifiers

- Previous history of concussion
- Greater number or severity of initial symptoms
- Female sex
- History of learning disorder
- ADD
- Migraines
- Mood disorders
 - Depression
 - Anxiety

Symptoms

- Physical
 - Headache
 - Dizziness
 - Nausea/vomiting
 - Changes in sleep latency
- Cognitive
 - Feeling “foggy”, slowed down
 - Difficulty concentrating
 - Amnesia
- Emotional

Incidence

- Recent increase in incidence of concussions
 - Increased awareness and reporting
 - Decrease in young athlete fitness
- 1.6-3.8 million annually
 - 5-9% of all sports-related injuries
- Football, wrestling, soccer (both sexes), girls' basketball

Reporting

- AAN 2013:
 - 919 athletes at UPenn were emailed survey, 262 responded
 - 43% with history of concussion had knowingly hidden symptoms to return to play
 - 22% overall would be unlikely or very unlikely to report symptoms to a coach or athletic trainer
 - Athletes with a prior history of concussion and male athletes were more likely to choose survey responses of “unlikely” or “extremely unlikely” for the future reporting questions

Preseason Evaluation

- As part of preseason physical:
 - Concussion history
 - Sport and position played
 - Baseline SCAT₃ or other sideline evaluation test

Sideline Evaluation

- ABCs
- Stabilize cervical spine
- Rule out a severe TBI/need for emergent imaging
 - Focal neurologic signs
 - Deteriorating mental status

Sideline Evaluation

- Zurich Guidelines (2012):
 - Player should be evaluated by physician/LHCP
 - Assessment of concussive injury with SCAT₃ or other sideline tool
 - Do not leave player alone following injury
 - Serial monitoring over initial post-injury period
 - A player with a diagnosed concussion should not be allowed to return to play on the day of the injury

Sideline Evaluation

- Once the athlete has been diagnosed with a concussion, the medical provider should:
 - Arrange follow up with the parent or guardian
 - Give take home information including:
 - Warning signs and symptoms, including signs that should prompt an ER trip
 - Avoiding cognitive and physical exertion
 - Avoiding NSAIDs

SCAT₃

1

Glasgow coma scale (GCS)

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) of 15

GCS should be recorded for all athletes in case of subsequent deterioration.

SCAT₃

2

Maddocks Score³

"I am going to ask you a few questions, please listen carefully and give your best effort."

Modified Maddocks questions (1 point for each correct answer)

What venue are we at today?	0	1
Which half is it now?	0	1
Who scored last in this match?	0	1
What team did you play last week./game?	0	1
Did your team win the last game?	0	1
Maddocks score	of 5	

Maddocks score is validated for sideline diagnosis of concussion only and is not used for serial testing.

SCAT₃

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

SYMPTOM EVALUATION

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
Nervous or Anxious	0	1	2	3	4	5	6

Total number of symptoms (Maximum possible 22)

Symptom severity score (Maximum possible 132)

Do the symptoms get worse with physical activity?

Y N

Do the symptoms get worse with mental activity?

Y N

self rated

self rated and clinician monitored

clinician interview

self rated with parent input

Overall rating: If you know the athlete well prior to the injury, how different is the athlete acting compared to his/her usual self?

Please circle one response:

no different

very different

unsure

N/A

SCAT₃

4

Cognitive assessment

Standardized Assessment of Concussion (SAC)⁴

Orientation (1 point for each correct answer)

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	

Immediate memory

List	Trial 1	Trial 2	Trial 3	Alternative word list
elbow	0 1	0 1	0 1	candle baby finger
apple	0 1	0 1	0 1	paper monkey penny
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	

SCAT₃

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) testing⁵

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

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

Condition

Double leg stance: _____ Errors

Single leg stance (non-dominant foot): _____ Errors

Tandem stance (non-dominant foot at back): _____ Errors

And / Or

Tandem gait^{6,7}

Time (best of 4 trials): _____ seconds

7 Coordination examination

Upper limb coordination

Which arm was tested: Left Right

Coordination score _____ of 1

SCAT₃

8

SAC Delayed Recall⁴

Delayed recall score

of 5

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

Office Evaluation

- Comprehensive history
- Detailed neurologic exam
- Change in clinical status
 - May involve seeking additional information from coaches, athletic trainers
- Determination of need for emergent neuroimaging

The Role of Imaging in Concussion

- Usually normal in concussion
- Should only be utilized when suspecting a more serious neurologic condition
 - Intracranial bleed
- CT is the test of choice to evaluate for cranial hemorrhage, skull fracture

Neuropsychological Testing

- Zurich Guidelines:
 - Application of neuropsychological testing is of clinical value, contributes significant information in concussion evaluation
 - Should be performed when athlete is asymptomatic, but there are situations when early performance is useful
 - Return to school in pediatric athletes
 - May be used to assist RTP decisions
 - Baseline NP testing currently does not have enough evidence to recommend widespread use

Concussion Management

- Physical and cognitive rest
 - 24-48 hours following the acute injury pt should avoid any kind of stimulation
- Graded program of exertion before full return to play
- Graded return to learning

Symptom Management

- Headache
 - Acetaminophen
 - Dim quiet environment with physical modalities
 - If headache persists past 3-4 days, abortive treatment aimed at specific headache type (cluster, migraine, etc)
- Sleep Disturbance
 - Good sleep hygiene
 - No role for sleep-promoting agent or stimulant

Symptom Management

- Mood Alteration
 - Depression is most common
 - If mood issues persist >6-12 weeks, treatment with medication and/or cognitive therapy should be considered
- Cognitive Symptoms
 - Decreasing academic responsibilities, other cognitive demands
- Balance/Vertigo
 - Careful evaluation prior to treatment
 - Meclizine, diazepam for acute attacks

Return to Play Guidelines

Table 1. Graduated Return to Play Protocol

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective of each stage
1. No activity	Symptom-limited physical and cognitive rest.	Recovery
2. Light aerobic exercise	Walking, swimming, or stationary cycling keeping intensity < 70% maximum permitted heart rate. No resistance training.	Increase heart rate
3. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities.	Add movement
4. Non-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
5. Full contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6. Return to play	Normal game play	

Return to Play Guidelines

- Each step of the protocol should take approximately 24 hours
- If athlete experiences symptoms → 24 hour rest period and return to previous asymptomatic stage
- Athletes should be symptom and medication free before returning to play

Return to Learning Guidelines

- Pediatrics: 10/27/2013
- Goal during concussion: avoid overexerting the brain to the level of worsening or reproducing symptoms
 - Increasing evidence that using the concussed brain to learn may worsen symptoms and prolong recovery
 - Recovery for school age students occurs within 3 weeks from injury
- Overall goal: minimal disruptions to student's life and return to school as early as possible

Return to Learning Guidelines

- Students benefit from multi-disciplinary team to maximize recovery

TABLE 2 Multidisciplinary Team to Facilitate “Return to Learning”¹

Team	Members of the Team
Family team	Student, parents, guardians, grandparents, peers, teammates, and family friends
Medical team	Emergency department, primary care provider, concussion specialist (primary care sports medicine physicians, neurologists, neurosurgeons, as examples), clinical psychologist, neuropsychologist, team and/or school physician
School academic team	Teacher, school counselor, school psychologist, social worker, school nurse, school administrator, school physician
School physical activity team	School nurse, athletic trainer, coach, physical education teacher, playground supervisor, school physician

All members listed for a team do not need to be involved for successful concussion management. An individual, such as an emergency department physician, may only be involved in the initial assessment and suggestion for initiating academic adjustments. Some members may serve roles on various teams. Some schools may have access to only certain individuals suggested for a team. This list is meant to serve as a framework to help pediatricians and others involved with concussion management, possible roles they can serve for a student with a concussion.

Return to Learning Guidelines

- Student is encouraged to return to school when they can tolerate 30-45 minutes of cognitive stimulation
- Observe which classes exacerbate symptoms and then adjust schedule accordingly
 - Replace with study hall
 - Shorter school day
- Academic team should reassess adjustments weekly for effectiveness and necessity

Return to Learning Guidelines

TABLE 4 Signs and Symptoms of a Concussion and the Strategies to Help in the School Setting

Sign/Symptom	Potential Adjustments in School Setting
Headache	Frequent breaks Identifying aggravators and reducing exposure to them
Dizziness	Rests, planned or as needed, in nurses office or quiet area Allow student to put head down if symptoms worsen Give student early dismissal from class and extra time to get from class to class to avoid crowded hallways
Visual symptoms: light sensitivity, double vision, blurry vision	Reduce exposure to computers, smart boards, videos Reduce brightness on the screens Allow the student to wear a hat or sunglasses in school Consider use of audiotapes of books Turn off fluorescent lights as needed Seat student closer to the center of classroom activities (blurry vision) Cover 1 eye with patch/tape 1 lens if glasses are worn (double vision)
Noise sensitivity	Allow the student to have lunch in quiet area with a classmate Limit or avoid band, choir, or shop classes Avoid noisy gyms and organized sports practices/games Consideration of the use of earplugs Give student early dismissal from class and extra time to get from class to class to avoid crowded hallways during pass time
Difficulty concentrating or remembering	Avoid testing or completion of major projects during recovery when possible Provide extra time to complete nonstandardized tests Postpone standardized testing (may require that 504 plan is in place) Consider 1 test per day during exam periods Consider the use of preprinted notes, notetaker, scribe, or reader for oral test taking
Sleep disturbances	Allow for late start or shortened school day to catch up on sleep Allow rest breaks

Maryland School Policy

- All coaches are required to be trained in, provide written verification of concussion awareness training
 - CDC, National Federation of State High School Association or the Oregon Center for Applied Science ACTive course
- Provide athletes and parents written information about the nature and risks of concussions
 - Parents and athletes must provide written verification of receiving information

Maryland School Policy

- Schools shall make academic accommodations for student-athletes with concussions
- Non-school youth athletic activities conducted on school property must assure that parents and participants are given concussion information
- Concussion resources available at every practice/competition where an athlete may sustain a concussion

Maryland School Policy

- Delineates between collision, contact, limited contact and no contact sports
- Collision and contact sports have practice restrictions, require coaches to teach proper contact techniques specialized by sport
 - Football: proper body-to-body contact, tackling techniques
 - Boys' Lacrosse: proper body checking techniques

More information can be found at
[http://www.mpssaa.org/HealthandSafety/Concussions.as
p](http://www.mpssaa.org/HealthandSafety/Concussions.asp)

Prolonged Concussive Symptoms

- Lasts weeks to months beyond initial injury
- Any symptom or constellation of symptoms can be involved
- Many potential, no proven causes
- Risk factors:
 - Increasing age
 - Female
 - Non-sports related concussion

Prolonged Concussion Symptoms

- Foundation of management: time
- Management by a team of providers, ideally who work with concussion frequently
- Cognitive therapy, integrated neurorehabilitation programs, supervised progressive exercise programs may improve recovery

Summary

- Concussion: mild TBI that may present with any number of symptoms, the most common including headache, dizziness, and balance disturbance
 - LOC is not a requirement for concussion diagnosis
- Biggest risk for getting a concussion is a previous history of concussions
- Recognition and initial assessment of concussion should be guided by a symptoms checklist, cognitive evaluation, balance tests and neurological physical exam

Summary

- Sideline evaluation with SCAT₃ or other standardized symptom checklist
- Physical and cognitive rest are the cornerstone of management
- Usual resolution of symptoms is within 7-10 days
- Return to play should be guided by a specific protocol with 6 stages taking 24 hours each
- Return to learning should be individualized based on patient's symptoms