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CONTINUED

Concussion: Management, Intervention, & Rehabilitation

Nov 13: Concussion Management Update: Recommendations from the Berlin Meeting
Tamara McLeod, PhD, ATC, FNATA

Nov 14: Chronic Post-Concussion Syndrome: Psychological and Cognitive Implications for Treatment
Brady Whetten, PT, DPT, GCS

Nov 15: Concussion: Conditioning the Brain and Body for Return to Sport
Guest Editor: Mike Studer, PT, MHS, NCS, CEEAA, CWT

Nov 16: Concussion and the Older Adult: Does Age Make a Difference?
Debbie Struiksma, PT, NCS

Nov 17: The Management of Cervicogenic Pain and Headaches After Concussion
Rene'e James, MSPT, OCS, CMP and Bailey Denno, PT, DPT

Concussion Management Update: Recommendations from the Berlin Meeting

ATSU
ATHLETIC TRAINING

Tamara C. Valovich McLeod, PhD, ATC, FNATA
John P. Wood, D.O., Endowed Chair for Sports Medicine

Professor and Director, Athletic Training Programs
Research Professor, School of Osteopathic Medicine in Arizona

Objectives

- Describe at least three steps in the process used to develop the Berlin concussion consensus statement.
- Identify at least two best practices according to the Berlin concussion consensus statement.
- Identify at least two sources of evidence supporting the Berlin recommendations.

5

Overview

- Berlin consensus statement development
- Overview of consensus statement
- Review of recommendations
  - 11 Rs
- Concussion statement use in clinical practice

6

Clinical Practice Guidelines

- Systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances (Institute of Medicine, 1990)
- Often developed to improve the quality of patient care
- Typically developed based on experience and judgment
- Shift in focus towards evidence-based clinical guidelines

7

Clinical Practice Guidelines

- To describe appropriate care based on the best available scientific evidence and broad consensus;
- To reduce inappropriate variation in practice
- To provide a more rational basis for referral
- To provide a focus for continuing education
- To promote efficient use of resources
- To act as focus for quality control, including audit
- To highlight shortcomings of existing literature and suggest appropriate future research

AAPM&R: http://www.aapmr.org/quality-practice/clinical-practice-guidelines

8

Benefits of Guideline Use

Patients	Healthcare Providers	Healthcare System
• Better quality of care • Improved health outcomes • Improved consistency of care • Inform patients • Empower patients in decision-making • Influence public policy • Promote distributive justice	• Better quality of clinical decisions • Reassure that practice is appropriate • Provide explicit recommendations to guide care • Reduce outdated, ineffective, or wasteful practice • Support QI initiatives • Inform the research agenda by identifying gaps in evidence	• Improve efficiency • Optimize value for money • Demonstrating adherence to guidelines may improve public image

Evidence-Based Healthcare & Public Health (2005) **9**, 308–314

9

Scalzitti, DA. Phys Ther, 2001; 81:1622-1628

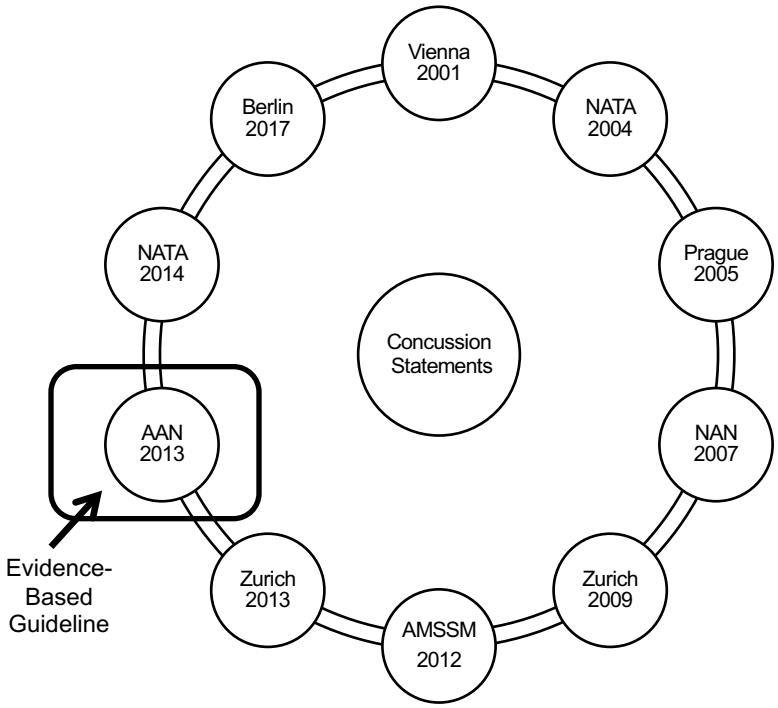
10

1.1-1.9 million concussions

Outpatient	ED	School (AT only)
377,000	115-166,000	86,000

Bryan, 2016

11



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The Berlin 2016 process: a summary of methodology for the 5th International Consensus Conference on Concussion in Sport

Willem H Meeuwisse,[1] Kathryn J Schneider,[1,2,3] Jiri Dvorak,[4] Onutobor (Tobi) Omu,[1] Caroline F Finch,[5] K. Alix Hayden,[6] Paul McCrory[7]

Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016

Paul McCrory,[1] Willem Meeuwisse,[2] Jiří Dvorak,[3,4] Mark Aubry,[5] Julian Bailes,[6] Steven Broglio,[7] Robert C Cantu,[8] David Cassidy,[9] Ruben J Echemendia,[10,11] Rudy J Castellani,[12] Gavin A Davis,[13,14] Richard Ellenbogen,[15] Carolyn Emery,[16] Lars Engebretsen,[17] Nina Feddermann-Demont,[18,19] Christopher C Giza,[20,21] Kevin M Guskiewicz,[22] Stanley Herring,[23] Grant L Iverson,[24] Karen M Johnston,[25] James Kissick,[26] Jeffrey Kutcher,[27] John J Leddy,[28] David Maddocks,[29] Michael Makdissi,[30,31] Geoff Manley,[32] Michael McCrea,[33] William P Meehan,[34,35] Sinji Nagahiro,[36] Jon Patricios,[37,38] Margot Putukian,[39] Kathryn J Schneider,[40] Allen Sills,[41,42] Charles H Tator,[43,44] Michael Turner,[45] Pieter E Vos[46]

13

NIH Consensus Development

Specific questions prepared and posed in advance to define the scope and guide the direction of the conference

Systematic literature reviews prepared and circulated in advance for use by the panel to address questions

Experts presented data in a public session, followed by inquiry and discussion

Expert panel met in closed session to prepare the consensus statement

The task of the panel was to elucidate responses to the questions

The consensus statement is intended to serve as the scientific record of the conference

Aim is to widely disseminate to achieve maximal impact on current practice and future research

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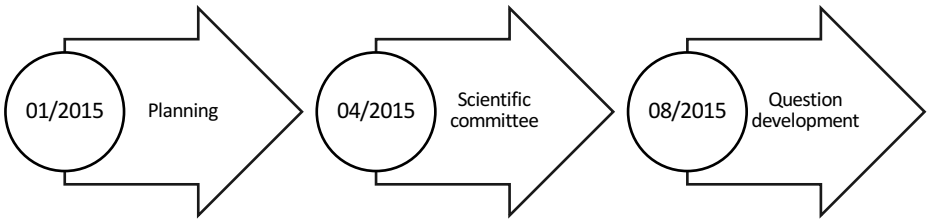
Meeuwisse, BJSM, 2017

Timeline



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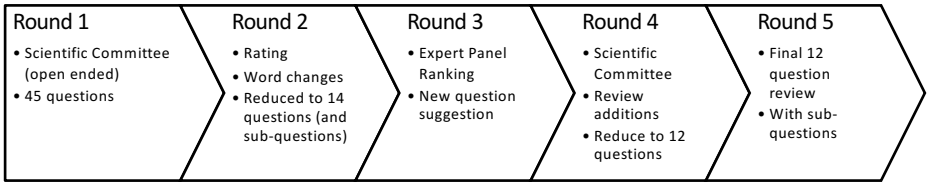
Consensus Question Development

- Modified Delphi Technique
- 5 rounds with Scientific Committee and Expert Panel
  - Scientific Committee – 10 members
  - Expert Panel – 35 members



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Meeuwisse, BJSM, 2017

Consensus Questions

1. What is the definition of concussion?
2. What are the critical elements of sideline screening that can be used to establish the diagnosis of concussion?
3. What tests and measures should be added to the SCAT3 and related tests to improve their reliability, sensitivity and/or specificity in sideline concussion diagnosis?
4. What domains of clinical function should be assessed post-injury?
5. What advanced or novel tests can assist in the evaluation of concussion?
6. What is the evidence for and efficacy of specific treatment interventions?

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Consensus Questions

7. What is the time course of physiological recovery after sports concussion?
8. What are the key modifiers of concussion outcomes?
9. What is the difference in concussion management in children as compared to adults?
10. What is the best approach to investigation and treatment of persistent post-concussive symptoms?
11. What is the current state of the scientific evidence about the prevalence, risk factors and causation of possible long term-term sequelae like CTE and other neurodegenerative diseases, with respect to sports concussion?
12. What strategies can be used to effectively reduce the risk of concussion in sport?

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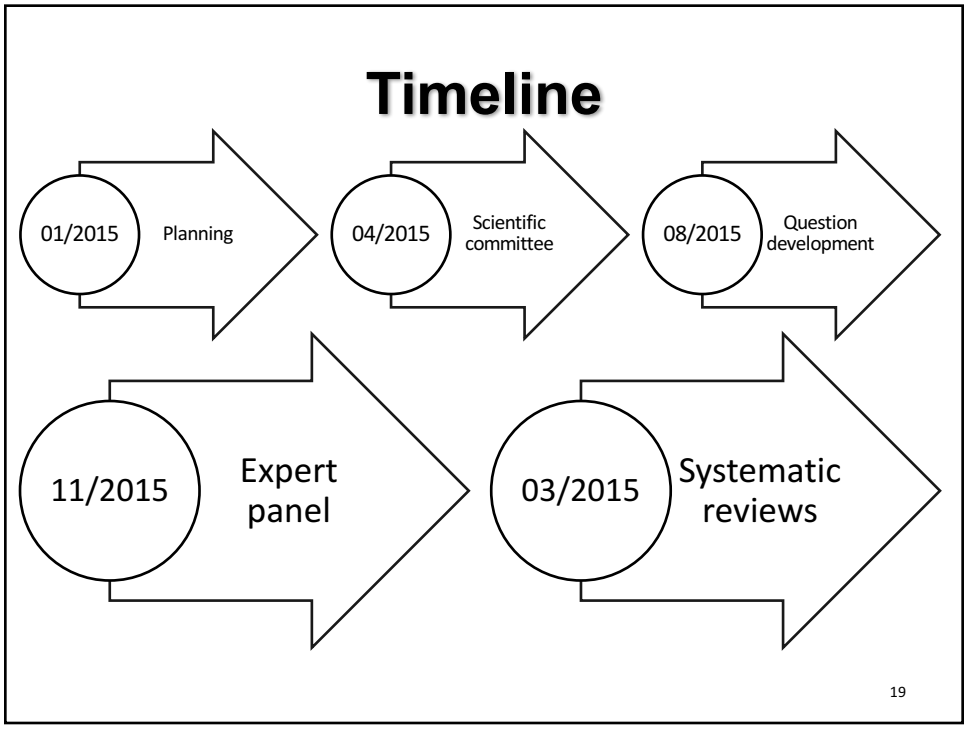


Systematic Reviews

- Develop an SR for each consensus question
- Ensure literature searched systematically
  - Methodological rigor
- Standardized guidelines
  - BJSM author instructions
  - PRISMA guidelines
- Focus on sport-related concussion
- Discussion could include other relevant literature

20

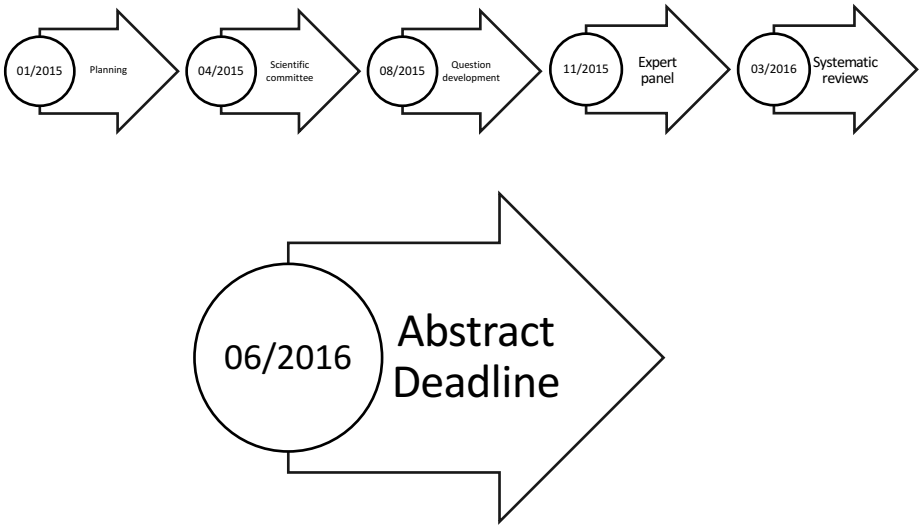
Meeuwisse, BJSM, 2017

Systematic Reviews

- Search strategy
  - Developed by content experts
  - Reviewed by medical librarians with expertise in systematic reviews
- Used risk of bias tools
- Lead author and Scientific Committee
  - Discussed overlap between questions
  - 7 meetings in final 5 months

21
Meeuwisse, BJSM, 2017

Timeline



22

Scientific Abstract Proposals

- Engaged clinicians and scientists outside of expert panel and writing groups
- 202 accepted
  - Compared to 56 in 2012
  - 178 posters and 24 oral presentations
- Possibility to be added to systematic reviews by providing the latest evidence

23
Meeuwisse, BJSM, 2017

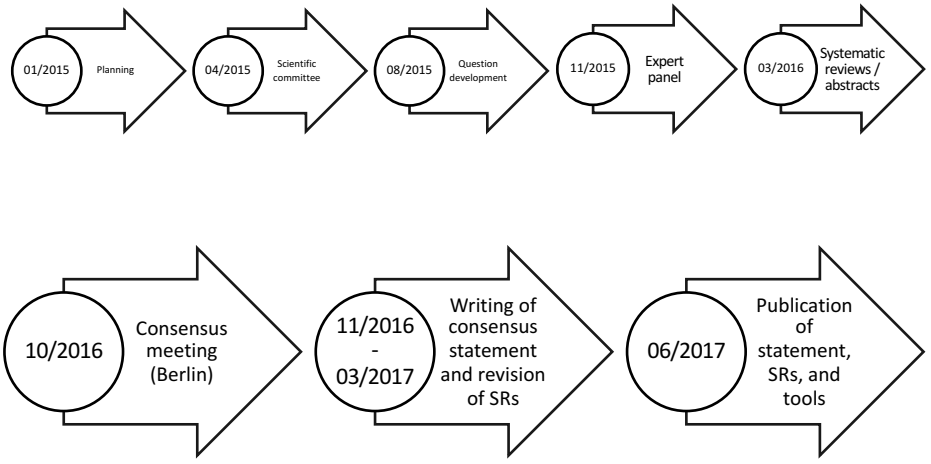
Consensus Meeting

October 2016 (Berlin)

Days 1 & 2	Day 3	Day 4
• Plenary sessions • 1-2 abstracts • SR overview • Discussion	• Closed meeting • Panel and observers • Review of sessions & discussion	• SCAT • Child SCAT • CRT **End Goal:** A simple, clear message and tools that will equip the practitioner to diagnose and manage concussion in sport

24
Meeuwisse, BJSM, 2017

Timeline



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Publications

- Methodological paper
- Consensus statement
- 12 systematic reviews
- Tool development papers
- Sport Concussion Assessment Tool-5 (SCAT5)
- Child SCAT5
- Concussion Recognition Tool (CRT)

26

Meeuwisse, BJSM, 2017

Berlin Consensus Statement 11 Rs

- Recognize
- Remove
- Re-evaluate
- Rest
- Rehabilitation
- Refer
- Recover
- Return to sport
- Reconsider
- Residual Effects
- Risk reduction

McCrory et al, *Br J Sport Med.* 2017

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Recognize: Defining Concussion

Sport related concussion is a traumatic brain injury induced by biomechanical forces

McCrory, BJSM, 2017

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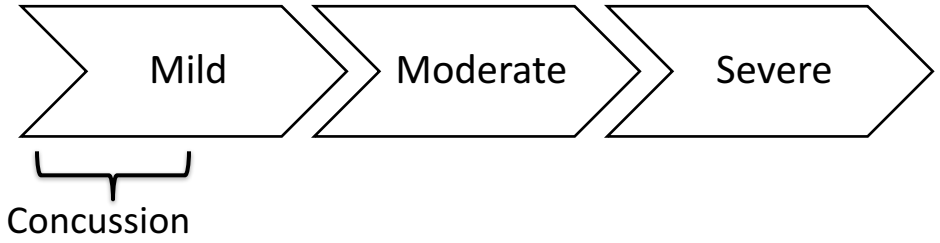
Concussion



Concussion

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Recognize: Features of Concussion

- May be caused either by a direct blow to the head, face, neck or elsewhere on the body with an impulsive force transmitted to the head
- Typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously
  - However, in some cases, signs and symptoms evolve over a number of minutes to hours
- May result in neuropathological changes, but the acute clinical signs and symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies
- Results in a range of clinical signs and symptoms that may or may not involve loss of consciousness
  - Resolution of the clinical and cognitive features typically follows a sequential course
  - However, in some cases symptoms may be prolonged

McCrory et al, *Br J Sport Med.* 2017

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Goals of the On-Field Evaluation

- **Implementation of EAP**
- Main goal is to rule out more serious injuries
  - Must recognize signs and symptoms of serious trauma such as LOC, cranial nerve deficits, decreasing mental status, and worsening symptoms
  - LOC, GCS < 15, focal neurology, and skull fracture were predictive of intracranial hemorrhage in children and adolescents (Dunning et al., 2004)
- Sideline evaluation serves as the benchmark for serial assessments

31

On-Field Primary Survey

- ABCC
  - Airway
  - Breathing
    - Respirations*
  - Circulation
    - Pulse*
    - Blood pressure*
  - C-spine

* Vitals = vital that they are recorded and monitored

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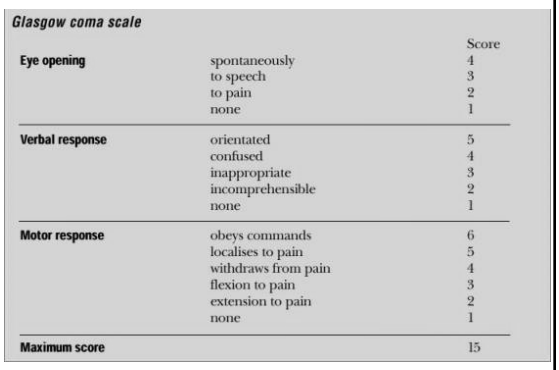
Level of Consciousness

- Alert
- Lethargic
- Stuporous
- Semi-comatose
- Comatose



Glasgow coma scale		Score
Eye opening	spontaneously	4
	to speech	3
	to pain	2
	none	1
Verbal response	orientated	5
	confused	4
	inappropriate	3
	incomprehensible	2
	none	1
Motor response	obeys commands	6
	localises to pain	5
	withdraws from pain	4
	flexion to pain	3
	extension to pain	2
	none	1
Maximum score		15

- Only **6.3%-8.9%** of collegiate athletes demonstrated LOC following a concussion (Guskiewicz et al, 2000 & 2003; McCrea et al, 2003)
- LOC does not necessarily imply severity (McCrory et al, 2004)

33

Berlin On-Field Screen

- Rapid screen
- Clear on-field signs
  - LOC
  - Ataxia
  - Tonic posturing
  - Post-traumatic seizure

Immediate Diagnosis of Concussion

Patricios, 2017

34

1

IMMEDIATE OR ON-FIELD ASSESSMENT

The following elements should be assessed for all athletes who are suspected of having a concussion prior to proceeding to the neurocognitive assessment and ideally should be done on-field after the first first aid / emergency care priorities are completed.

If any of the "Red Flags" or observable signs are noted after a direct or indirect blow to the head, the athlete should be immediately and safely removed from participation and evaluated by a physician or licensed healthcare professional.

Consideration of transportation to a medical facility should be at the discretion of the physician or licensed healthcare professional.

The GCS is important as a standard measure for all patients and can be done serially if necessary in the event of deterioration in conscious state. The Maddocks questions and cervical spine exam are critical steps of the immediate assessment; however, these do not need to be done serially.

STEP 1: RED FLAGS

RED FLAGS:

- Neck pain or tenderness
- Double vision
- Weakness or tingling/ burning in arms or legs
- Severe or increasing headache
- Seizure or convulsion
- Loss of consciousness
- Deteriorating conscious state
- Vomiting
- Increasingly restless, agitated or combative

STEP 2: OBSERVABLE SIGNS

Witnessed ☐ Observed on Video ☐

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

STEP 3: MEMORY ASSESSMENT MADDOCKS QUESTIONS[2]

"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

Note: Appropriate sport-specific questions may be substituted.

Name: _____
DOB: _____
Address: _____
ID number: _____
Examiner: _____
Date: _____

STEP 4: EXAMINATION

GLASGOW COMA SCALE (GCS)[3]

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

CERVICAL SPINE ASSESSMENT

Does the athlete report that their neck is pain free at rest?	Y	N
If there is NO neck pain at rest, does the athlete have a full range of ACTIVE pain free movement?	Y	N
Is the limb strength and sensation normal?	Y	N

In a patient who is not lucid or fully conscious, a cervical spine injury should be assumed until proven otherwise.

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SCAT5 Immediate / On-Field Assessment

McCrory, 2017

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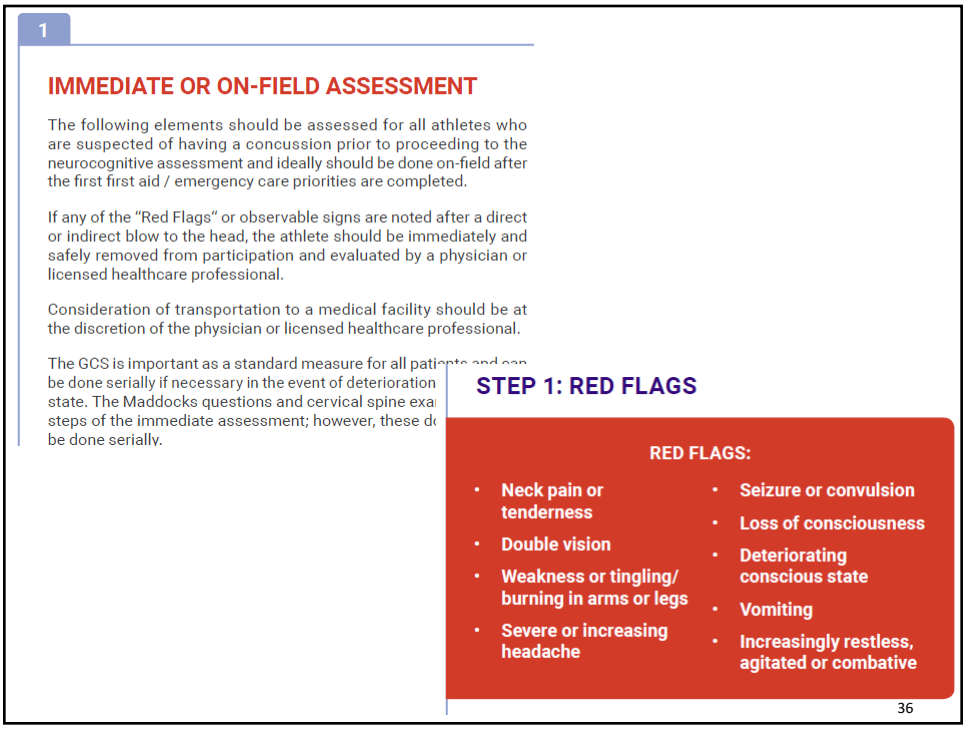

1

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- Severe or increasing headache
- Seizure or convulsion
- Loss of consciousness
- Deteriorating conscious state
- Vomiting
- Increasingly restless, agitated or combative

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Immediate Referral

- Deteriorating level of consciousness (LOC)
- Loss of or fluctuating LOC
- Increased confusion
- Inability to recognize people and places
- Increased irritability
- Worsening headache
- Repeated vomiting
- Extremity numbness
- Signs of skull fracture
- Focal findings on neuro exam
- Seizure
- GCS <13

Anderson & Schnebel, 2016; Hyden & Petty, 2016

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Recognize: Sideline Screen

Rapid screening for a *suspected SRC*, rather than the definitive diagnosis

Clear on-field signs of SRC (should immediately be removed
- LOC, tonic posturing, balance impairments

Suspected SRC following a significant head impact or with symptoms can proceed to sideline screening using appropriate assessment tools

More thorough diagnostic evaluation, which should be performed in a distraction-free environment

McCrory et al. *Br J Sport Med.* 2017

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Berlin Sideline Screen

- Symptom reporting and interview
- Verbal cognitive evaluation (eg. SAC)
  - Maddocks questions, SAC
  - Not meant to replace formal cognitive testing
- Balance evaluation (BESS, Tandem gait)
- Serial Assessments
- Clinical examination

McCrory et al, *Br J Sport Med.* 2017

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Critical	• Observe signs • Symptom reporting and interview • Verbal cognitive evaluation (eg. SAC) • Balance evaluation (BESS, Tandem gait) • Serial Assessments • Clinical examination
Corroborating	• Video replay • Great to have if available
Complimentary	• King-Devick • Needs more studies
Confounding	• Head impact sensors • Research tool only

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SCAT5® SPORT CONCUSSION ASSESSMENT TOOL – 5TH EDITION
DEVELOPED BY THE CONCUSSION IN SPORT GROUP
FOR USE BY MEDICAL PROFESSIONALS ONLY

supported by

Patient details
Name:
DOB:
Address:
ID number:
Examiner:
Date of Injury: Time:

WHAT IS THE SCAT5?

The SCAT5 is a standardized tool for evaluating concussions designed for use by physicians and licensed healthcare professionals[1]. The SCAT5 cannot be performed correctly in less than 10 minutes.

If you are not a physician or licensed healthcare professional, please use the Concussion Recognition Tool 5 (CRT5). The SCAT5 is to be used for evaluating athletes aged 13 years and older. For children aged 12 years or younger, please use the Child SCAT5.

Preseason SCAT5 baseline testing can be useful for interpreting post-injury test scores, but is not required for that purpose.Detailed instructions for use of the SCAT5 are provided on page 7. Please read through these instructions carefully before testing the athlete. Brief verbal instructions for each test are given in italics. The only equipment required for the tester is a watch or timer.

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Recognise and Remove

A head impact by either a direct blow or indirect transmission of force can be associated with a serious and potentially fatal brain injury. If there are significant concerns, including any of the red flags listed in Box 1, then activation of emergency procedures and urgent transport to the nearest hospital should be arranged.

Key points

- Any athlete with suspected concussion should be REMOVED FROM PLAY, medically assessed and monitored for deterioration. No athlete diagnosed with concussion should be returned to play on the day of injury.
- If an athlete is suspected of having a concussion and medical personnel are not immediately available, the athlete should be referred to a medical facility for urgent assessment.
- Athletes with suspected concussion should not drink alcohol, use recreational drugs and should not drive a motor vehicle until cleared to do so by a medical professional.
- Concussion signs and symptoms evolve over time and it is important to consider repeat evaluation in the assessment of concussion.
- The diagnosis of a concussion is a clinical judgment, made by a medical professional. The SCAT5 should NOT be used by itself to make, or exclude, the diagnosis of concussion. An athlete may have a concussion even if their SCAT5 is "normal".

Remember:

- The basic principles of first aid (danger, response, airway, breathing, circulation) should be followed.
- Do not attempt to move the athlete (other than that required for airway management) unless trained to do so.
- Assessment for a spinal cord injury is a critical part of the initial on-field assessment.
- Do not remove a helmet or any other equipment unless trained to do so safely.

SCAT-5

- On-field assessment
- Office assessment
  - Symptoms
  - Cognition
  - Neurological screen
- Take home instructions

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Child SCAT5® SPORT CONCUSSION ASSESSMENT TOOL
FOR CHILDREN AGES 5 TO 12 YEARS
FOR USE BY MEDICAL PROFESSIONALS ONLY

supported by

Patient details
Name:
DOB:
Address:
ID number:
Examiner:
Date of Injury: Time:

WHAT IS THE CHILD SCAT5?

The Child SCAT5 is a standardized tool for evaluating concussions designed for use by physicians and licensed healthcare professionals[1].

If you are not a physician or licensed healthcare professional, please use the Concussion Recognition Tool 5 (CRT5). The Child SCAT5 is to be used for evaluating Children aged 5 to 12 years. For athletes aged 13 years and older, please use the SCAT5.

Preseason Child SCAT5 baseline testing can be useful for interpreting post-injury test scores, but not required for that purpose. Detailed instructions for use of the Child SCAT5 are provided on page 7. Please read through these instructions carefully before testing the athlete. Brief verbal instructions for each test are given in italics. The only equipment required for the tester is a watch or timer.

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Recognise and Remove

A head impact by either a direct blow or indirect transmission of force can be associated with a serious and potentially fatal brain injury. If there are significant concerns, including any of the red flags listed in Box 1, then activation of emergency procedures and urgent transport to the nearest hospital should be arranged.

Key points

- Any athlete with suspected concussion should be REMOVED FROM PLAY, medically assessed and monitored for deterioration. No athlete diagnosed with concussion should be returned to play on the day of injury.
- If the child is suspected of having a concussion and medical personnel are not immediately available, the child should be referred to a medical facility for urgent assessment.
- Concussion signs and symptoms evolve over time and it is important to consider repeat evaluation in the assessment of concussion.
- The diagnosis of a concussion is a clinical judgment, made by a medical professional. The Child SCAT5 should NOT be used by itself to make, or exclude, the diagnosis of concussion. An athlete may have a concussion even if their Child SCAT5 is "normal".

Remember:

- The basic principles of first aid (danger, response, airway, breathing, circulation) should be followed.
- Do not attempt to move the athlete (other than that required for airway management) unless trained to do so.
- Assessment for a spinal cord injury is a critical part of the initial on-field assessment.
- Do not remove a helmet or any other equipment unless trained to do so safely.

Child SCAT-5

- Ages 5-12
- Standardized tool for administration by HCPs
  - On-field
  - Symptoms
  - Cognition
  - Neurological
  - Balance
- Take home instructions

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Concussion Recognition Tool

- Recognition and removal tool for the layperson
- Not diagnostic
- Red flags
- Signs, symptoms, awareness
- Suspicion of concussion should result in removal with no return until assessed and cleared by appropriate HCP
- Home instructions

Echemendia, BJSM, 2017

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CONCUSSION RECOGNITION TOOL 5©

To help identify concussion in children, adolescents and adults

Supported by

RECOGNISE & REMOVE

Head impacts can be associated with serious and potentially fatal brain injuries. The Concussion Recognition Tool 5 (CRT5) is to be used for the identification of suspected concussion. It is not designed to diagnose concussion.

STEP 1: RED FLAGS — CALL AN AMBULANCE

If there is concern after an injury including whether ANY of the following signs are observed or complaints are reported then the player should be safely and immediately removed from play/game/activity. If no licensed healthcare professional is available, call an ambulance for urgent medical assessment:

- Neck pain or tenderness
- Double vision
- Weakness or tingling/ burning in arms or legs
- Severe or increasing headache
- Seizure or convulsion
- Loss of consciousness
- Deteriorating conscious state
- Vomiting
- Increasingly restless, agitated or combative

Remember:

- In all cases, the basic principles of first aid (danger, response, airway, breathing, circulation) should be followed.
- Assessment for a spinal cord injury is critical.
- Do not attempt to move the player (other than required for airway support) unless trained to so do.
- Do not remove a helmet or any other equipment unless trained to do so safely.

If there are no Red Flags, identification of possible concussion should proceed to the following steps:

STEP 2: OBSERVABLE SIGNS

Visual clues that suggest possible concussion include:

- Lying motionless on the playing surface
- Slow to get up after a direct or indirect hit to the head
- Disorientation or confusion, or an inability to respond appropriately to questions
- Blank or vacant look
- Balance, gait difficulties, motor incoordination, stumbling, slow laboured movements
- Facial injury after head trauma

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STEP 3: SYMPTOMS

- Headache
- "Pressure in head"
- Balance problems
- Nausea or vomiting
- Drowsiness
- Dizziness
- Blurred vision
- Sensitivity to light
- Sensitivity to noise
- Fatigue or low energy
- "Don't feel right"
- More emotional
- More Irritable
- Sadness
- Nervous or anxious
- Neck Pain
- Difficulty concentrating
- Difficulty remembering
- Feeling slowed down
- Feeling like "in a fog"

STEP 4: MEMORY ASSESSMENT

(IN ATHLETES OLDER THAN 12 YEARS)

Failure to answer any of these questions (modified appropriately for each sport) correctly may suggest a concussion:

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

Athletes with suspected concussion should:

- Not be left alone initially (at least for the first 1-2 hours).
- Not drink alcohol.
- Not use recreational/ prescription drugs.
- Not be sent home by themselves. They need to be with a responsible adult.
- Not drive a motor vehicle until cleared to do so by a healthcare professional.

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ANY ATHLETE WITH A SUSPECTED CONCUSSION SHOULD BE IMMEDIATELY REMOVED FROM PRACTICE OR PLAY AND SHOULD NOT RETURN TO ACTIVITY UNTIL ASSESSED MEDICALLY, EVEN IF THE SYMPTOMS RESOLVE

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Remove

- Suspected concussion should be removed from the sporting environment
  - Multimodal assessment should be conducted in a standardized fashion (eg, the SCAT5)
- Sporting bodies should allow adequate time to conduct this evaluation
  - SCAT alone typically takes 10 min
- Adequate facilities should be provided for the appropriate medical assessment
  - On and off the field for all injured athletes.
  - May require rule changes to allow an appropriate off-field medical assessment to occur without affecting the flow of the game or unduly penalizing the injured player's team.
- Final determination regarding SRC diagnosis and/or fitness to play is a medical decision based on clinical judgement

McCrory et al, *Br J Sport Med.* 2017

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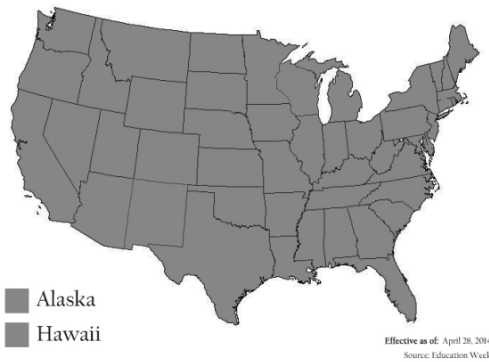
Legislation



- **Education**
- **Removal from Play**
- **Return to Play**

- Return to School
- Liability
- Informed Consent

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Concussion Reporting After Legislation

- Rate of concussion documentation in Washington HSs significantly increased in both the first (RR = 2.10; 95% CI = 1.50, 2.93) and second (RR = 2.10; 95% CI = 1.49, 2.93) years after the Lystedt Law (Bompadre et al., 2014)
  - Athletes were held out of play 6.9 days longer
- Pediatric ED visits in Rhode Island saw a doubling of the overall rate of concussion (2.20 increase; 95% CI = 1.3, 3.6) (Mackenzie et al., 2015)

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Concussion Legislation

- Between 2009-2012 increase in healthcare utilization (Gibson, 2014)
  - 92% in states with legislation
  - 75% in states without
  - 40% of the increase attributed to state laws

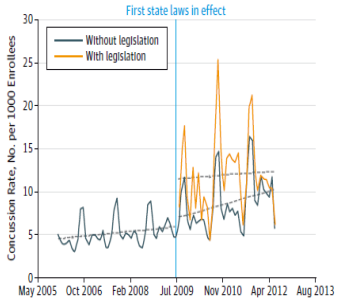

Table 1. States With Concussion Legislation in Effect by Year of Implementation

Year	State
2009	Oregon, Washington
2010	Connecticut, Idaho, Oklahoma, Rhode Island, Massachusetts, New Mexico, New Jersey
2011	Alabama, Alaska, Arizona, DC,[a] Iowa, Illinois, Indiana, Kansas, Louisiana, Maryland, Missouri, Minnesota, North Carolina, North Dakota, Nevada, South Dakota, Texas, Utah, Virginia, Vermont, Wyoming
2012	California, Colorado, Kentucky, Wisconsin, Maine, Florida, Nebraska, New York, Pennsylvania, Hawaii, Delaware, New Hampshire
2013	Ohio, Montana, Michigan, South Carolina, Arkansas, West Virginia
2014	Georgia, Tennessee, Mississippi

[a] Washington, DC.

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Most State Law Removal Language

- … SUSPECTED OF SUSTAINING A CONCUSSION … BE IMMEDIATELY REMOVED FROM THE ATHLETIC ACTIVITY
- MAY RETURN TO PLAY ON THE SAME DAY IF A HEALTH CARE PROVIDER RULES OUT A SUSPECTED CONCUSSION AT THE TIME THE PUPIL IS REMOVED FROM PLAY.

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Re-evaluate: Follow-Up Exam

Medical assessment

- Comprehensive history and detailed neurological examination including a thorough assessment of mental status, cognitive functioning, sleep/ wake disturbance, ocular function, vestibular function, gait and balance

Determination of the clinical status of the patient

- Has been improvement or deterioration since the time of injury
- May involve seeking additional information from those close to patient

Determination of need for emergent imaging

- Red flags for intracranial bleed

McCrory et al, *Br J Sport Med.* 2017

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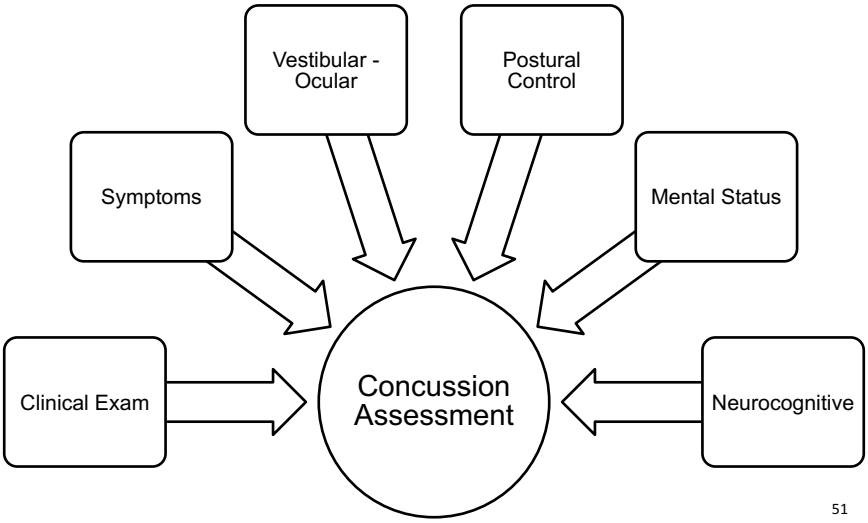
Follow-Up Evaluations



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Re-evaluate: Neurocognitive

- Baseline testing not felt to be required as a mandatory aspect of every assessment
  - May be helpful or add useful information to the overall interpretation of these tests
  - Provides an educational opportunity for the healthcare provider to discuss the significance of concussion
- Post-injury neurocognitive testing is not required for all athletes
  - If used should be performed by a trained and accredited neuropsychologist

McCrory et al, *Br J Sport Med.* 2017

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Re-evaluate: Physiologic

- Advanced neuroimaging
- Fluid biomarkers and
- Genetic testing
- Important research tools
- Require further validation to determine clinical utility

McCrory et al, *Br J Sport Med.* 2017

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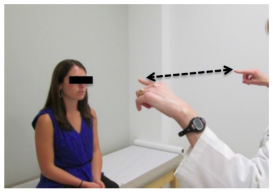
Vestibular Ocular Motor Screening (VOMS)

Systematic method to evaluate oculomotor function

- Ages 9-40
- Abnormal findings or provocation of symptoms may indicate dysfunction and result in referral
- Equipment
  - Tape measures
  - Metronome
  - Target with 14 point font

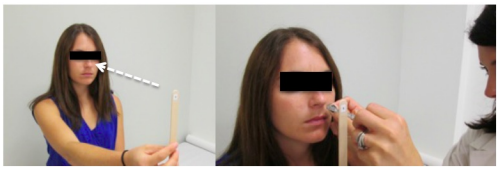
Mucha, *AJSM*, 2014

Smooth pursuits



Horizontal Saccades

Vertical Saccades



Convergence

Horizontal VOR
Also complete Vertical VOR

Visual Motion Sensitivity

Mucha, *AJSM*, 2014

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						

Mucha, *AJSM*, 2014

VOMS Considerations

Advantages
- Easy to administer
- High correlation with symptoms
- High sensitivity: (+) identify concussion
- Assists in targeted treatment plan

Possible Limitations
- Unknown inter-tester reliability
- Relying on symptoms can result in recall bias
- Convergence only measured test
- No correlation to BESS
  - May not be sensitive to dynamic vestibular function

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Rest

- Brief period (24–48 hours) of complete rest
- Gradually and progressively more active
  - Staying below their cognitive and physical symptom
  - Avoid heavy exertion
- The exact amount and duration of rest is not yet well defined

Schneider, BJSM, 2017

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Clinical Questions

1. How often is cognitive and physical rest, including academic adjustments, utilized by health care providers in managing sport-related concussion?
2. In patients sustaining a concussion, does the use of physical and cognitive rest reduce the severity and duration of concussion-related impairments?

Valovich McLeod, Lewis, Whelihan, Welch Bacon, *J Athl Train. 2017*. 59

Study	Key Results
Arbogast, 2013	62% of physicians described awareness of CR as part of management; only 2.4% described CR in detail 11% of charts reviewed included written CR recommendations
Carson, 2014	Worsening of symptoms in 44.7% of patients following premature RTL Patients with prior history of concussion required more rest days before being cleared
Grubenhoff , 2015	Patients with PPCS missed 50% more school days than patients with no PPCS 36% of PPCS patients received AA, while 53% of no PPCS patients received AA There was an association between follow-up visits and receiving AA (RR=2.2; 95% CI = 1.4-3.5)
Olympia, 2015	58% of SN are responsible for guiding students' graduated academic re-entry process
Upchurch, 2014	CR was not recommended to any patient prior to 2008 CR was only recommended to 12% of patients by 2012
Weber, 2015	59.4% of student-athletes with concussion under SN care received AA, yet only 27.7% of SN always or almost always recommend AA following sport-related concussion
Wilkins, 2013	Instructions for RTT increased from 24% prestandardization to 98% poststandardization
Williams, 2015	41% of student-athletes with concussion under AT care received AA
Zemek, 2015	CR recommendations were limited; 40% of physicians sis not recommend school absence, 30% did not recommend schoolwork reduction, 35% did not recommend limiting screen time

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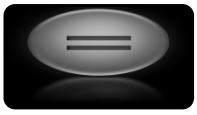
Valovich McLeod, Lewis, Whelihan, Welch Bacon, *J Athl Train.* In press.

Effectiveness of Rest

3 studies showing too much activity delayed recovery = worse outcomes (Majerske, 2008; Brown, 2014; Maerlender, 2015)

2 studies show rest improves outcomes (Moser, 2012, 2015)



4 studies found no association between rest and outcomes (Gibson, 2013; Buckley, 2015; Moor, 2015; deKruijk, 2002)

1 RCT found strict rest resulted in a longer recovery (Thomas, 2015)

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Clinical Bottom Line

1. Physical and cognitive rest is underutilized by healthcare providers (SOR= B)
   - Need to educate community providers regarding best practices for rest, treatment, and activity
   - Develop strategies to build a collaborative concussion management team
2. Moderate physical and cognitive rest may facilitate recovery during the initial days after concussion (SOR = B)
   - Recommendations for rest are broad and not specific for individual patients
   - An initial period of rest may be beneficial
   - Balance rest and active treatments for each patient
   - For athletic trainers, these decisions are ones that should be made in conjunction with their directing physician and in collaboration with other concussion team members

Valovich McLeod, Lewis, Whelihan, Welch Bacon, *J Athl Train.* 2017.

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Activity or Rest?

- School or exercise activity
- School activity only
- School activity and light activity at home
- School and sports practice
- School and sports games

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Majerske, *JAT*, 2008

Rehabilitation

- A variety of treatments may be required for ongoing symptoms and impairments
- Cervical and vestibular rehabilitation
  - Persisting dizziness, c-spine pain and headaches
- Closely monitored active rehabilitation programmes
  - Controlled subsymptom threshold, submaximal exercise
- Specific treatments based on clinical examination findings and symptoms.

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Schneider, BJSM, 2017

Targeted Treatments

Cognitive/Fatigue	• Difficulty concentrating, overall fatigue, decreased energy levels • Reduce cognitive and physical demands • Regulate sleep, stress, diet, and mild exercise (1 short walk/day)
Vestibular	• Dizziness, fogginess, nausea, anxiety, overstimulation by complex environments • Brought on with rapid head or body movements • Vestibular rehabilitation
Ocular Motor	• Localized, frontal-based headaches, fatigue, distractibility, difficulty with vision, pressure behind eyes, trouble focusing • Consult with neuro-optometrist, vestibular therapist • Rehabilitation with vision therapy specialist

Collins, 2013

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Targeted Treatments

Anxiety/Mood	• Overall increase in anxiety, perhaps with sleep disturbance and vestibular issues • Treat vestibular issues • Begin physical exertion protocols and regulate sleep
Post-traumatic Migraine	• Moderate to severe headache with nausea and photosensitivity or phonosensitivity, often exaggerated by physical activity and stress • Pharmacologic intervention
Cervical	• Headache and neck pain • ROM, manual cervical and thoracic mobilization, posture education, biofeedback, soft tissue mobilization

Collins, 2013

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Rehabilitation Strategies

- Adaptation
  - Ability of the vestibular system to make long-term changes in the neuronal response to input
- Substitution
  - Using other strategies to replace lost function
- Habituation
  - Reduction in symptoms produced through repeated exposure to the movement

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X1 Exercises

- Stationary target
- Subject moves head
  - Horizontal and vertical
- Maintains visual fixation on target
- Target should remain clear (focused) while head is moving

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X1 Errors

- Not keeping the eyes on the target
  - Instead glancing from side to side
- Making the head movement too large
  - Patient is looking out of the corner of the eyes
- Not moving the head in a consistent in this movement
  - Not staying horizontal

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Remembered Target Exercise

- Patient fixates on a small target
- Closes eyes, pretending to look at that target
- Patient makes a horizontal head movement, trying to remember where the target is
- Opens eyes to check whether or not they are still looking at the target
- Aims to foster central pre-programming of eye movements

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X2 Exercises

- Target and the head move in opposite directions
- Patient focuses on target

- **Errors**
  - Similar to X1 errors
  - Confusion when trying to move head and target in opposite directions
    - Results in VOR cancellation

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Dual Task Strategies

- Combined postural control and cognitive tasks
- Retrain executive attentional networks
- Secondary cognitive activities improve postural control (Wulf, 2001; Huxhold, 2006; Resch, 2011)

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Examples of Vestibular Exercises

- **Gaze Stabilization-** eyes fixed stationary object move head side to side & up/down
- **Smooth Pursuit-** eyes fixed on target. Move target side to side & up/down or 2 targets apart move eyes between 2 targets (side to side & up/down)
- **Head and eyes same direction** -fix eyes on target (ie thumb) move target (side to side & up/down) head & eyes in same position
- **Head and eye opposite direction** -fix eyes move target and head in opposite direction

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Vestibular Rehabilitation After Concussion

Intervention	Outcomes
• Gaze stabilization (X1) • Standing balance • Walking with balance challenges • Canilith repositioning	• ↓ Dizziness rating • ↑ Activities-specific balance confidence scale • ↓ DHI • ↑ Dynamic gait index • ↑ Functional gait assessment • ↓ TUG • ↑ SOT (all conditions)

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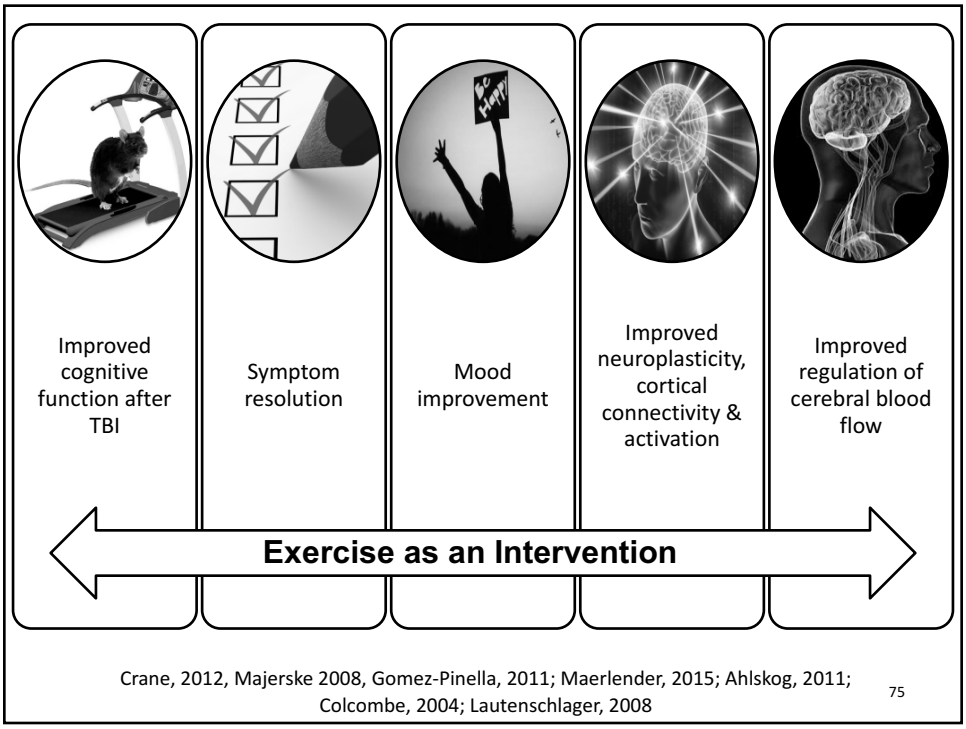
Alsalaheen, *JNPT*, 2010



Crane, 2012, Majerske 2008, Gomez-Pinella, 2011; Maerlender, 2015; Ahlskog, 2011; Colcombe, 2004; Lautenschlager, 2008

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Active Rehabilitation

- Exercise has a positive effect on mental health
- Closely monitored rehabilitation in post-acute phase improved recovery time in adolescents who were slow to recover (Gagnon, *Brain Inj*, 2009)
- Controlled sub-symptom threshold aerobic exercise improved recovery in athletes with PCS (Leddy, *CJSM*, 2010, 2011)

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Buffalo Concussion Treadmill Test

- Test to determine exercise tolerance
  - Helps to establish physiological recovery
  - Readiness to return to activity
- Modified Balke Protocol
  - 3.6mph @ 0% incline for 1 minute
  - Increase incline by 1% each minute after
  - Until maximal incline or patient cannot complete
  - RPE, HR, BP, symptoms assessed each 2 minutes
- Test is stopped with increased symptoms
  - >3 points from pre-test resting symptom score

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Buffalo Concussion Treadmill Test

- Good intra-rater reliability and sufficient test-retest reliability (Leddy, 2011)
- Recovery in high school athletes (Darling, 2014)
  - All athletes returned to sport without symptom exacerbation or recurrent symptoms
  - 48% had one or more CNT sub-scores below average
  - BCTT better predicted readiness to begin RTP protocol

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Buffalo Concussion Treadmill Test

- Assists with differential diagnosis (Leddy, 2013)
  - Patients with concussion stop at submaximal level
  - If able to exercise to exhaustion without replicating symptoms then symptoms not due to physiologic concussion
  - Cervical injury
  - Vestibular / ocular dysfunction
  - Post-traumatic headache or migraine

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Buffalo Concussion Treadmill Test

- Assist with exercise treatment (Leddy, 2016)
  - Aerobic exercise 20 min/day @ 80% threshold HR
  - 5-6 days per week
  - Terminate if symptoms appear or after 20 minutes

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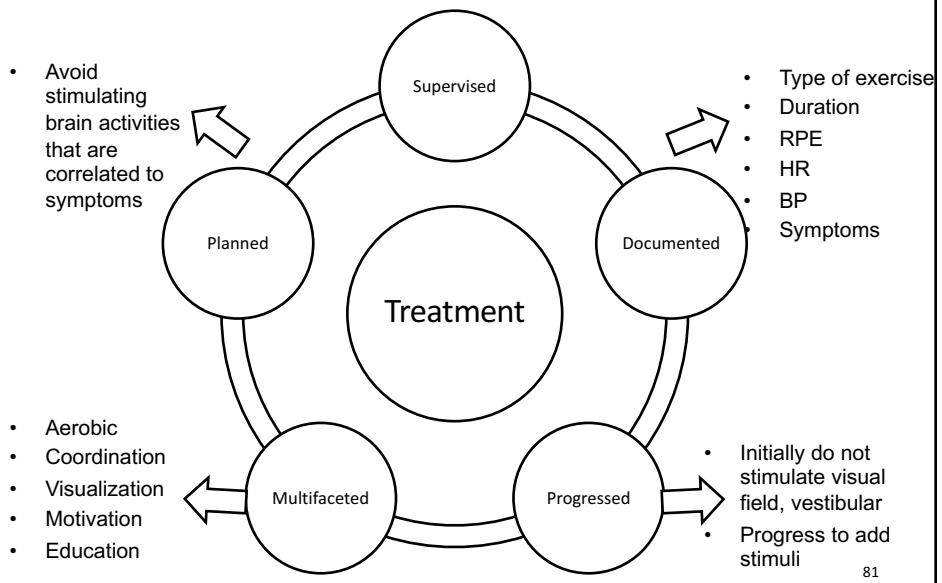
Exercise Interventions



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Referral

- Neurologist
  - Prolonged symptoms, sleep disturbances
- Neuropsychologist
  - Cognitive deficits, school issues
- Vestibular therapist
  - Dizziness and balance issues

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Refer: Treatment

- Preliminary evidence supporting
- Individualized symptom-limited aerobic exercise programs
  - Patients with persistent post-concussive symptoms associated with autonomic instability or physical deconditioning
- Targeted physical therapy
  - Patients with cervical spine or vestibular dysfunction
- Collaborative approach including cognitive behavioral therapy
  - Persistent mood or behavioral issues.

McCrory et al, *Br J Sport Med.* 2017

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Refer: Persistent Symptoms

- Beyond expected time frames (ie, >10–14 days in adults and >4 weeks in children)
- Multimodal clinical assessment
  - Needed to identify specific primary and secondary pathologies that may be contributing to persisting post-traumatic symptoms
- Treatment should be individualized
  - Target-specific medical, physical and psychosocial factors identified

McCrory et al, *Br J Sport Med.* 2017

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Concussion Management Team

- Athletic Trainer
- Sports Medicine/Team Physician
- Sport Physical Therapist
- Vestibular Therapist
- Neurologist
- Neurosurgeon
- Neuropsychologist
- Occupational Therapist
- School Nurse
- Speech & Language Pathologist
- Physical Medicine & Rehabilitation physician
- Ocular Therapist
- Behavior Optometrist
- Psychologist
- Psychiatrist

Adjunct Team Members

Coach, Teacher, Academic Counselor, Family

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Team Leader/ Coordinator

- Not specific to any specialist
  - Determined by specific situation
  - Depending on the availability of resources, expertise and geographic barriers
- Role
  - Identify the predominant concussion profile/subtype/deficits
  - Coordinate referral to the appropriate medical specialist
  - More thorough evaluation, targeted management and/or treatment
- Should have an understanding of the sport and environment of sport and school
- Vital to consider patient goals (i.e., return to play expectations) when developing a treatment and return to sport plan

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Concussion Management Team at HS Level

Team	Team Members	Roles
Family	Patient, parents, guardians, relatives, peers, teammates, family friends	Impose rest Monitor and track symptoms at home including emotional and sleep-related symptoms daily Communicate with school teams
Medical	Primary care provider, team physician, emergency department, concussion specialist, neuropsychologist, other medical referrals	Rule out more serious injury Evaluate patient periodically Coordinate information from other teams Encourage physical and cognitive rest
School Academic	School nurse, school counselor, teachers, school psychologist, social worker, school administrator, school physician, school occupational or physical therapist	Reduce cognitive load Meet with patient to create academic adjustments Watch, monitor, and track academic and emotional issues
School Physical Activity	Athletic trainer, school nurse, coach, physical education teacher, school physician, playground supervisor	Watch, monitor, and track physical symptoms Athletic trainer should do daily follow-up examinations Ensure no physical activity

Williams & Valovich McLeod, Quick Consult: Concussion, 2015

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Recovery

- Strongest and most consistent predictor of slower recovery from concussion is initial symptom burden
  - Low level of symptoms in the first day after injury is a favorable prognostic indicator
- Development of subacute problems are likely risk factors for persistent symptoms
  - Migraine headaches or depression
  - Children, adolescents and young adults with a pre-injury history of mental health problems
- ADHD and LD do not appear to be risk for persistent symptoms

McCrory et al, *Br J Sport Med.* 2017

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Re-Evaluate: Physiological

- The following are the three main clinical questions to be addressed:
  1. *How does the time course of physiological recovery compare to the time line of clinical recovery?*
  2. *Should there be a minimum stand-down period post-injury?*
  3. *Is there evidence supporting a change in the duration or content of the graded return to play (RTP) progression?*

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Kamins , Bigler , Covassin , Henry , Kemp , Leddy , Mayer, McCrea, Prims, Schneider, Valovich McLeod, Zemek , Giza . *Br J Sports Med*. In press

Physiological Recovery Evidence

Modality	Confidence in the Evidence
fMRI	Low – no consensus for recovery
FTI / MRI	Low
MRS	Low – no consensus for recovery
Cerebral blood flow	Low
EEG	Low
HR variability	Low
Exercise (BCTT)	No conclusion (only PCS)
Biomarkers	Low – most change but not consistent
TMS	Low

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Return to Sport

- Brief period of initial rest (24-48 hr)
- Symptom limited activity
- Off medications
- Full return to school
- Return to baseline on adjunct assessments
  - Neurocognitive
  - Balance

Broglio, 2014, McCrory, 2017

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Modifying Factors

TABLE 2. Concussion Modifiers

Factors	Modifier
Symptoms	Number
	Duration (>10 days)
	Severity
Signs	Prolonged LOC (>1 min), amnesia
Sequelae	Concussive convulsions
Temporal	Frequency - repeated concussions over time
	Timing - injuries close together in time
	"Recency" - recent concussion or TBI
Threshold	Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion
Age	Child and adolescent (<18 years old)
Co- and Pre-morbidities	Migraine, depression or other mental health disorders, attention deficit hyperactivity disorder (ADHD), learning disabilities (LD), sleep disorders
Medication	Psychoactive drugs, anticoagulants
Behaviour	Dangerous style of play
Sport	High-risk activity, contact and collision sport, high sporting level

More Conservative Management

McCrory, 2009

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Table 1 Graduated return-to-sport (RTS) strategy

Stage	Aim	Activity	Goal of each step
1	Symptom-limited activity	Daily activities that do not provoke symptoms	Gradual reintroduction of work/school activities
2	Light aerobic exercise	Walking or stationary cycling at slow to medium pace. No resistance training	Increase heart rate
3	Sport-specific exercise	Running or skating drills. No head impact activities	Add movement
4	Non-contact training drills	Harder training drills, eg, passing drills. May start progressive resistance training	Exercise, coordination and increased thinking
5	Full contact practice	Following medical clearance, participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6	Return to sport	Normal game play	

NOTE: An initial period of 24–48 hours of both relative physical rest and cognitive rest is recommended before beginning the RTS progression.
There should be at least 24 hours (or longer) for each step of the progression. If any symptoms worsen during exercise, the athlete should go back to the previous step.
Resistance training should be added only in the later stages (stage 3 or 4 at the earliest). If symptoms are persistent (eg, more than 10–14 days in adults or more than 1 month in children), the athlete should be referred to a healthcare professional who is an expert in the management of concussion.

~24 hours between each stage

McCrory et al, 2017

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Rest and Return-to-Activity Following Sport-Related Concussion: A Systematic Review of the Literature

1. How <u>compliant</u> are healthcare providers in following current return-to-activity guidelines?
2. How <u>effective</u> are the graded return-to-activity protocols in improving patient outcomes following concussion?

Valovich McLeod, Lewis, Whelihan, Welch Bacon, *J Athl Train.* 2017.

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Compliance With Return to Activity Guidelines

- No study found full compliance with using all three recommended areas of concussion-assessment for return-to-play
  - Symptoms, cognitive, balance
- Significant variability among guideline use by physicians
  - Clinical exam cited most for RTA clearance
- Lack of compliance with NCAA guidelines
- Inadequate ED discharge instructions regarding activity restrictions

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Valovich McLeod, Lewis, Whelihan, Welch Bacon, *J Athl Train.* In press.

Effectiveness of RTA Progression

- No studies specifically evaluated the effectiveness of graded RTA progressions in improving patient outcomes
  - 4 studies evaluated aspects of Zurich statement
- Zurich guidelines + BCTT may provide a useful paradigm for making safe RTA decisions (Darling, 2014)
- Use of a SFWP did not improve clinical outcomes or decrease the risk of a same-season repeat concussion (McCrea, 2009)

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Valovich McLeod, Lewis, Whelihan, Welch Bacon, *J Athl Train.* In press.

Rehabilitation After Return

- More prone to musculoskeletal injury?
- Decreased athletic performance?
- Monitoring and documenting symptoms score after the patient has returned
- Continue with vestibular or ocular therapy

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Decreased Athletic Performance

- Concussion vs. bereavement/paternity leave
  - 2 weeks after return (Wasserman, 2015)
    - Batting average
    - On-base percentage
    - Slugging percentage
    - On-base plus slugging
- No difference in player performance after concussion among NFL players (Kumar, 2014)

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Injury After Concussion

- Athletes with concussion were
  - More prone to injury following return (Nordstrom, 2014; Cross 2015; Brooks, 2016; Lynall, 2015)
  - More prone to injury in the year prior to the concussion (Nordstrom, 2014)
- Retired NFL players (Pietrosimone, 2015)
  - History of concussion associated with a history of musculoskeletal injuries during NFL careers.
  - Higher number of concussions is linked with higher odds of reporting a mskel injury

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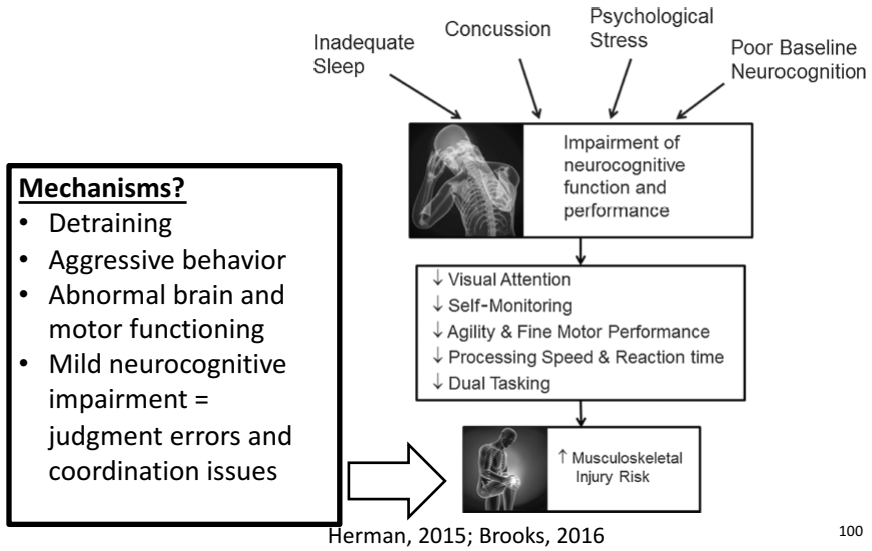
Injury After Concussion



Mechanisms?
- Detraining
- Aggressive behavior
- Abnormal brain and motor functioning
- Mild neurocognitive impairment = judgment errors and coordination issues

Herman, 2015; Brooks, 2016

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Reconsider: Elite vs Nonelite

- Should be managed using the same management principles

McCrory et al, *Br J Sport Med.* 2017

101

Reconsider: Pediatric

- Requires special paradigms suitable for the developing child and adolescent (<18)
  - Child – ages 5-12
  - Adolescent – ages 13-18
- Expected duration of symptoms is 4 weeks
- Age-specific, validated tools
  - Questionable role and utility of computerized testing
- Need to address academics
  - Successfully return to school first, then sport!

McCrory et al, *Br J Sport Med.* 2017

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Age and Recovery

- Collegiate athletes (McCrea, 2003)
  - Cognitive resolution 3-5 days
  - Symptom resolution 7 days
  - 91% recovered within 7 days
- High school athletes (Iverson, 2006; Collins, 2006)
  - Cognitive resolution 10 days
  - Symptom resolution 7 days
  - 40-50% recovered within 7 days

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Age & Recovery

- HS vs college resulted in no differences in cognitive, balance, or symptom recovery (Nelson, 2016)
  - Recovery at or before day 7 in both groups
- No difference in symptom presence, symptom severity, and total symptoms between HS and college at baseline or at post-concussion testing (Lee, 2013)
- Age not associated with prolonged symptom duration (Meehan, 2013)

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Return to School Laws

- As of November 2016
- 9 states
  - Illinois, Massachusetts, Maryland, Maine, Nebraska, New York, Oklahoma, Virginia and Vermont

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Effects of Concussion on Learning

Somatic	Cognitive	Sleep	Emotional
• Affects ability to function in class • Unsteadiness • Concentration difficulty	• Difficulty learning and retaining new information	• Results in issues with cognition, behavior, and mood • Decreased alertness in class	• Anxiety can hinder cognition • Adherence to prescribed rest

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Concussion & Academic Outcomes

Negative

- Cumulative GPA significantly lower in youth with 2+ concussions & recent concussion (Moser, 2005)
- Higher academic dysfunction scores 1 week after concussion compared to extremity injured (Wasserman, 2016)
- Symptomatic students had increased level of concern for impact of concussion on academic performance and more school related problems (Ransom, 2015)
- Vision symptoms, hearing difficulty, and concentration difficulty were significantly associated with academic difficulty (Swanson, 2016)
- 79% of ATs managed patient who experienced a decrease in school and academic performance following concussion (Williams, 2015)

None

- Concussion did not alter academic outcomes when using end of year GPA (Russel, 2016)

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Medical – School Partnership

- Effective and efficient communication of the students' needs
- Student's symptom profile can be communicated to the team
- Periodic in-school monitoring of symptom progress can be conducted
  - Cognitive activity log

Gioia, 2016

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Ideal Policy

Brief description of mild traumatic brain injury/ concussion

Definition of the school ‘‘receiving team’’ to guide reentry

The gradual process to assist the student’s return into school life (learning, social activity, etc.),

Criteria for when students can safely return to physical activity and full cognitive activity

Gioia, 2016

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Residual Effects and Sequelae

- Neurobehavioral sequelae and long-term consequences of exposure to recurrent head trauma is inconsistent
  - Potential for long-term problems such as cognitive impairment, depression in the management of **all** athletes
- Potential for developing chronic traumatic encephalopathy (CTE) must be a consideration

McCrory et al, *Br J Sport Med.* 2017

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Risk Reduction: PPE

- Concussion history
- Prior symptoms
- Length of recovery
- Prior head, face, spine injuries
- Educational opportunity

McCrory et al, *Br J Sport Med.* 2017

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Concussion History on PPE

- High school retrospective survey (Valovich McLeod et al, *Clin J Sport Med*, In Press)
  - PPE and concussion symptom survey
    - 8.1% reported concussion
    - 3.7% reported "knocked out"
    - 24.0% reported "bell rung"
  - 55.0% reported having concussion symptoms following a head injury
    - 86.4% did not report a concussion history in sport
    - 92.7% did not report a concussion history in recreational activities

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AIA PPE Form: Neuro Section

ARIZONA INTERSCHOLASTIC ASSOCIATION, INC.
7007 North 18th Street, Phoenix, Arizona 85020-5552
Phone: (602) 385-3810

ANNUAL PREPARTICIPATION PHYSICAL EVALUATION

7. Have you ever had a head injury or concussion? ☐ ☐
Have you ever been knocked out, become unconscious, or lost your memory? ☐ ☐
Have you ever had a seizure? ☐ ☐
Do you have frequent or severe headaches? ☐ ☐
Have you ever had numbness or tingling in your arms, hands, legs, or feet? ☐ ☐
Have you ever had a stinger, burner, or pinched nerve? ☐ ☐

http://www.aiaonline.org/story/uploads/Form_15.7_A_1183392595.pdf

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PPE

- Thorough neurologic history should be included within the medical history portion of the PPE
  - Often lacks an adequate series of questions regarding concussion history
- Ask questions regarding perceived previous concussions
- Include specific questions focusing on previous concussion-related <u>symptoms</u> sustained during both sport and non-sport activity

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PPE

- The most recent PPS guidelines recommend asking the following concussion-related questions as part of the neurologic screening:
  - "Have you ever had a head injury or concussion?"
  - "Have you been hit in the head and been confused or lost your memory?"
  - "Do you have headaches with exercise?"

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Positive Concussion History: Follow Up Questions

- When the athlete had the head injury?
- Able to finish the practice or game in which the injury was sustained?
- Missed any practices or games due to the injury?
- Referred to primary care provider?
- Imaging tests such as radiographs or CT scans?
- Hospitalized for the injury?

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Positive Concussion History: Follow Up Questions

- Nature and duration of concussive symptoms
- Lingering symptoms
- Was adjunct testing (neuropsychological, postural stability) used?
- Degree to which the concussion affected their performance in school?

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Emergency Action Plan

- Venue-specific written EAP
- Rehearsed with all involved personnel
  - Location of emergency equipment
  - Ambulance entrance
  - Roles of all personnel
- Communication plan
- Include EMS and receiving care facilities
- Documentation
- Reviewed and approved by administration and legal

Anderson, 2002

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Risk Reduction: Prevention

- Limited evidence for helmets in reducing concussion risk
  - Reduction of overall head injury in skiing/ snowboarding to support mandated helmet use in skiing/snowboarding
- Mixed evidence for mouthguard use
  - Non-significant trend in collision sports
- Consistent evidence related to body checking in youth ice hockey
  - Demonstrates a consistent protective effect

McCrory et al, *Br J Sport Med.* 2017

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Risk Reduction: Prevention

- Promising results
  - Vision training in collegiate American football players may reduce concussion risk
  - Limiting contact in youth football practices has demonstrated reducing the frequency of head contact,
    - No evidence to support the translation of these findings to a reduction in concussions

McCrory et al, *Br J Sport Med.* 2017

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Statement Use in Clinical Practice

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Statement Use in Clinical Practice

- Focus of the statement
  - Which providers?
  - Patient population (eg. AAP)
- Feasibility to implement in your setting
  - Medical direction
  - Equipment, supplies
  - Personnel

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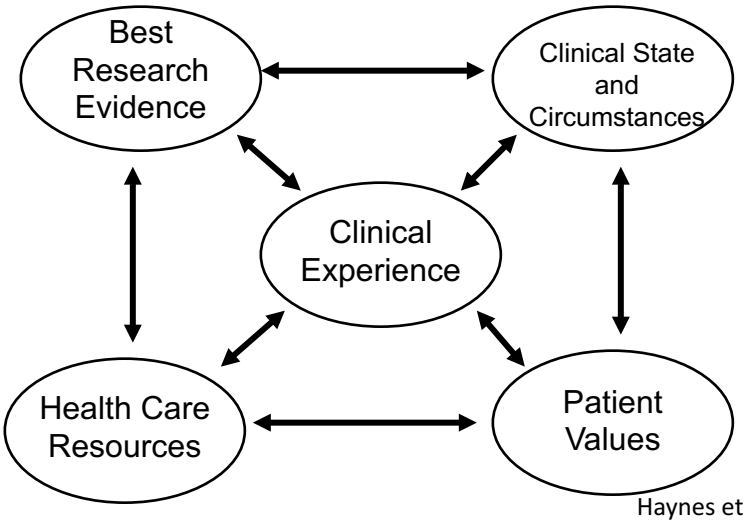
Statement Use in Clinical Practice



Haynes et al. 2002

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Statement Similarities: Diagnosis

- Clinical diagnosis
  - Neurologic exam
  - Graded symptom scale
  - Mental status
  - Balance
- Imaging not useful for concussion diagnosis or recovery
  - Misconception even among HCPs

Harmon, 2012; McCrory, 2013; Giza 2013; Broglio, 2014

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Statement Similarities: Assessment

- Multifactorial
  - Symptoms, cognition, balance
- Standardized tests = useful framework
  - Limited psychometrics, especially in different age groups, cultural groups, settings
- Finding from individual tests should not be used in isolation
- If neurocognitive testing is used it should be interpreted by a trained individual
  - Ideally neuropsychologist

Harmon, 2012; McCrory, 2013; Giza 2013; Broglio, 2014

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Statement Similarities: Management

- No same day RTP
- Serial monitoring
- Cognitive and physical rest
- Consider temporary academic adjustments
- Graduated RTP progression
  - Asymptomatic
  - More conservative in pediatric patient

Harmon, 2012; McCrory, 2013; Giza 2013; Broglio, 2014

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Statement Similarities: Prevention

- Primary prevention may be modified with rule changes and behavior modification
- Helmets, headgear, and mouthguards **do not** prevent concussion
- Secondary prevention may be possible if concussions are managed appropriately

Harmon, 2012; McCrory, 2013; Giza 2013; Broglio, 2014

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Neurocognitive Recommendations

Vienna (2001)

- **Cornerstone** of concussion evaluation
- Contributes **significantly** to understanding the injury and management of the individual

Prague (2004)

- Cornerstone of evaluation in **complex** concussion
- **Aid** to clinical decision making
- Not done while athlete is symptomatic

Zurich (2008)

- **Not the sole basis** for decision making
- Neuropsychologist is best to interpret
- Most cases not done until athlete is asymptomatic

Berlin (2016)

-Aid to clinical decision-making
-Computerized tests not substitutes for full NP evaluation
-Baseline and postingjury testing not required

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Statement Differences: Neurocognitive Testing

AMSSM	AAN	NATA	Berlin
• Most can be managed without cognitive testing • Paper and pencil tests can be more comprehensive and assess for other conditions	• Memory, RT, processing speed may be used to identify presence of concussion • Insufficient evidence for use in preadolescent	• Athletes at high risk of concussion should undergo baseline testing • New baseline completed annually for adolescents • Baseline should be multifactorial and include neurocognitive testing	• Aid to clinical decision-making • -Computerized tests not substitutes for full NP evaluation • -Baseline and postingjury testing not required

Harmon, 2012; Giza 2013; Broglio, 2014; McCrory, 2017

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Take Home Points

- Critical to understand development process
- Be aware of statements for other members of your concussion management team
  - Focus of the statement
    - Which providers?
    - Patient population (eg. AAP)
- Feasibility to implement in your setting
  - Medical direction
  - Equipment, supplies
  - Personnel

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ATSU Concussion Program | Athletic Training

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AT PBRN
Athletic Training Practice-Based Research Network
www.atpbrn.org

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