

Guidelines for Best Practice: Recommendations from the Berlin Concussion Meeting



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Objectives

- Discuss the process used to develop the Berlin concussion consensus statement.
- Identify best practices according to the Berlin concussion consensus statement.
- Discuss the evidence supporting the Berlin recommendations.

Overview

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

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

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.aapm.org/quality-practice/clinical-practice-guidelines>

Benefits of Guideline Use

Patients	Healthcare Providers	Healthcare System
<ul style="list-style-type: none"> • Better quality of care • Improved health outcomes • Improved consistency of care • Inform patients • Empower patients in decision-making • Influence public policy • Promote distributive justice 	<ul style="list-style-type: none"> • 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of clinical decisions • Reassure that practice is appropriate • Provide explicit recommendations to guide care • Reduce outdated, ineffective, or wasteful practice • Support QI initiatives • Inform the research agenda by identifying gaps in evidence 	<ul style="list-style-type: none"> • Improve efficiency • Optimize value for money • Demonstrating adherence to guidelines may improve public image

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

Implementation of Guidelines

- Presence of guidelines does not guarantee that the recommendations will improve the outcome for an individual patient
- Barriers to implementation
 - Environmental, financial, cultural, lack of knowledge regarding performance

National Guideline Clearinghouse

- Initiative of AHRQ
- Mission:
 - To provide physicians and other health professionals, health care providers, health plans, integrated delivery systems, purchasers, and others an accessible mechanism for obtaining objective, detailed information on clinical practice guidelines and to further their dissemination, implementation, and use.

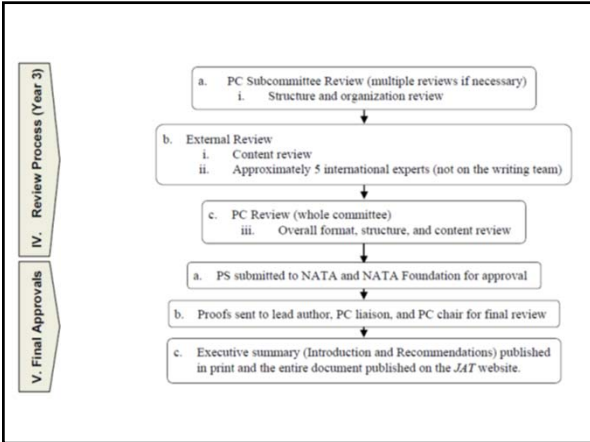
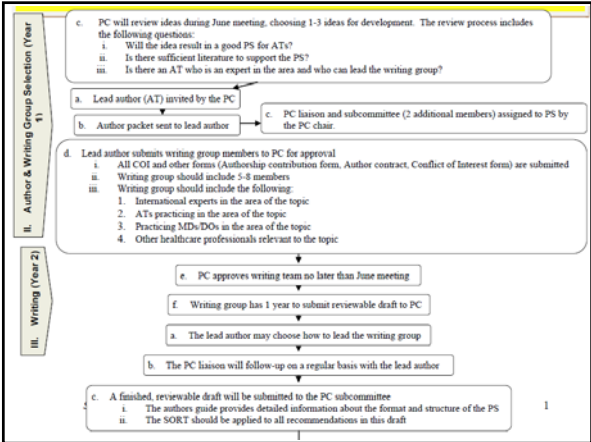
NGC

- Clinical practice guidelines are systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances.
- [Institute of Medicine. (1990). Clinical Practice Guidelines: Directions for a New Program, M.J. Field and K.N. Lohr (eds.) Washington, DC: National Academy Press. page 38].

NATA Position Statements

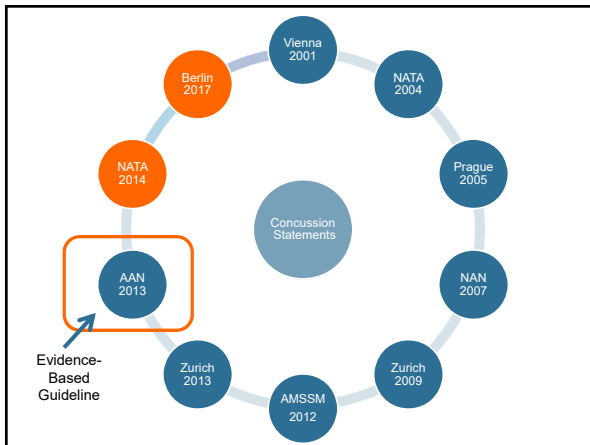
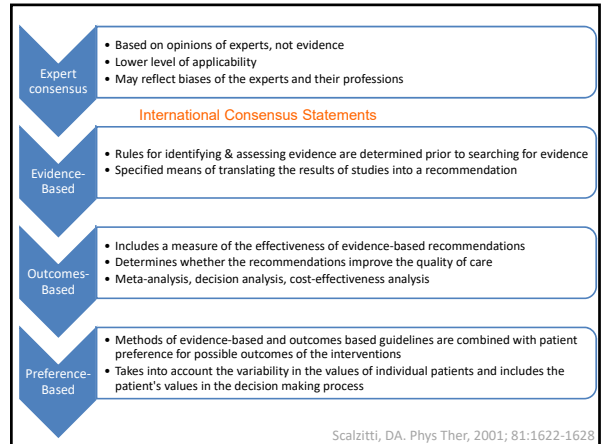
- Purpose: to declare the official NATA and NATA Foundation stance on an approved topic based on current literature and practice
- Recommendations and clinical considerations
 - Stand alone statements
 - SORT criteria
- Background – Literature review
 - Referenced review of the relevant issues related to the position statement
 - Focus on the papers with the highest levels of evidence
 - Evidence-based review should support each recommendation

NATA Foundation, Position Statement Author's Guide



DISCLAIMER

The NATA and NATA Foundation publish position statements as a service to promote the awareness of certain issues to their members. The information contained in the position statement is neither exhaustive nor exclusive to all circumstances or individuals. Variables such as institutional human resource guidelines, state or federal statutes, rules, or regulations, as well as regional environmental conditions, may impact the relevance and implementation of these recommendations. The NATA and NATA Foundation advise members and others to carefully and independently consider each of the recommendations (including the applicability of same to any particular circumstance or individual). The position statement should not be relied upon as an independent basis for care but rather as a resource available to NATA members or others. Moreover, no opinion is expressed herein regarding the quality of care that adheres to or differs from the NATA and NATA Foundation position statements. The NATA and NATA Foundation reserve the right to rescind or modify its position statements at any time.

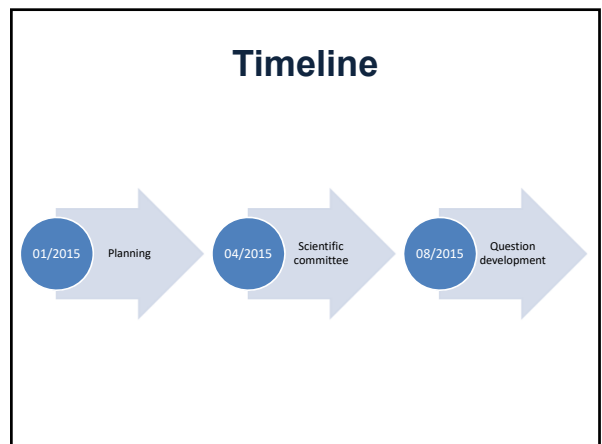
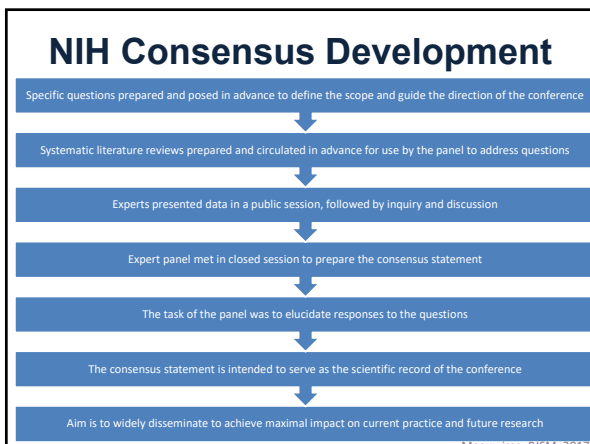


The Berlin 2016 process: a summary of methodology for the 5th International Consensus Conference on Concussion in Sport

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 McCrory⁷

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 Jiri 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 Vos⁴⁶



Consensus Question Development

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

Meeuwisse, BISM, 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?

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?

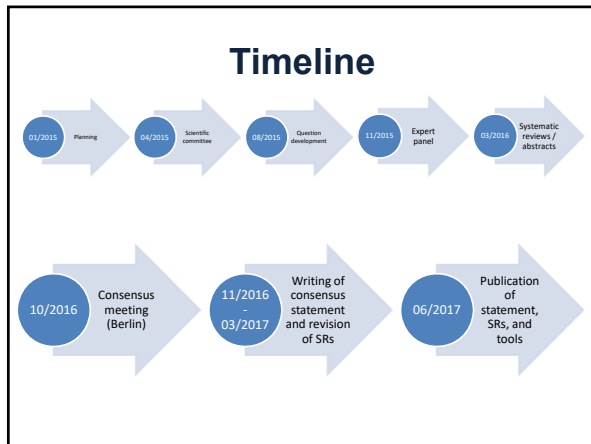
Timeline

Timeline

Consensus Meeting October 2016 (Berlin)

Days 1 & 2	Day 3	Day 4
<ul style="list-style-type: none"> • Plenary sessions • 1-2 abstracts • SR overview • Discussion 	<ul style="list-style-type: none"> • Closed meeting • Panel and observers • Review of sessions & discussion 	<ul style="list-style-type: none"> • SCAT • Child SCAT • CRT <p>End Goal: A simple, clear message and tools that will equip the practitioner to diagnose and manage concussion in sport</p>

Meeuwisse, BISM, 2017



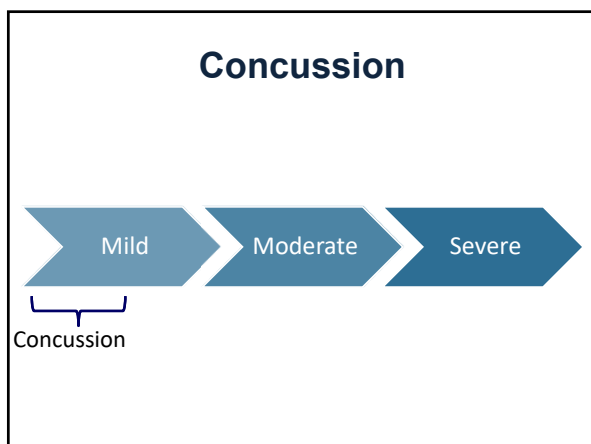
- ### Publications
- Methodological paper
 - Consensus statement
 - 12 systematic reviews
 - Tool development papers
 - Sport Concussion Assessment Tool-5 (SCAT5)
 - Child SCAT5
 - Concussion Recognition Tool (CRT)
- Meeuwisse, BJSM, 2017

- ### Berlin Consensus Statement 11 Rs
- Recognize
 - Remove
 - Re-evaluate
 - Rest
 - Rehabilitation
 - Refer
 - Recover
 - Return to sport
 - Reconsider
 - Residual Effects
 - Risk reduction
- McCroory et al. Br J Sport Med, 2017

Recognize: Defining Concussion

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

McCroory, BJSM, 2017



- ### Recognize: Concussion Features
- 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
- McCroory et al. Br J Sport Med, 2017

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

Berlin On-Field Screen

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

} Immediate Diagnosis of Concussion

Patricios, 2017

SCAT5 Immediate / On-Field Assessment

McCrory, 2017

STEP 1: 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

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

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

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


Critical	<ul style="list-style-type: none"> • Observe signs • Symptom reporting and interview • Verbal cognitive evaluation (eg. SAC) • Balance evaluation (BESS, Tandem gait) • Serial Assessments • Clinical examination
Corroborating	<ul style="list-style-type: none"> • Video replay • Great to have if available
Complimentary	<ul style="list-style-type: none"> • King-Devick • Needs more studies
Confounding	<ul style="list-style-type: none"> • Head impact sensors • Research tool only



SCAT-5
SPORT CONCUSSION ASSESSMENT TOOL - 5TH EDITION
FOR USE BY MEDICAL PROFESSIONALS ONLY

SCAT-5

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



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

Child SCAT-5

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

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



CONCUSSION RECOGNITION TOOL 5[®]
To help identify concussion in children, adolescents and adults

STEP 3: SYMPTOMS

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

Recognise and Remove

STEP 1: RED FLAG - CALL AN AMBULANCE

If there is concern after an injury including whether ANY of the following signs or symptoms are observed from the player, should be taken and emergency services called for professional assessment. If the player's condition is not stable, call for an ambulance for urgent medical assessment.

STEP 2: OBSERVABLE SIGNS

Visual clues that suggest possible concussion include:

- Long unresponsive on the playing surface
- Does not get up after 10 minutes or after 10 minutes on the ground
- Loss of consciousness
- Balance, gait difficulties, stumbling, dizziness
- Inability to respond appropriately to questions
- Head or neck pain
- Facial injury after head trauma

STEP 4: MEMORY ASSESSMENT

Failure to answer any of these questions modified appropriately for each sport carefully may suggest a concussion.

- "What colour was the ball?"
- "What team did you play last week/game?"
- "Which half is it now?"
- "Did your team win the last game?"
- "Who scored last in the game?"

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.

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

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

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

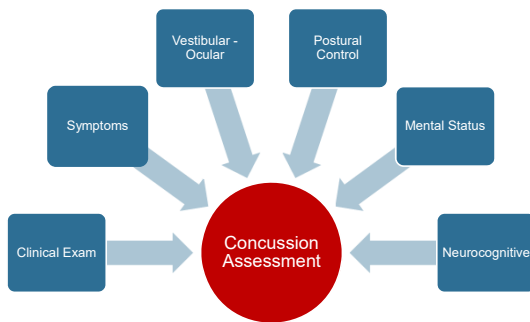
- Has been improvement or deterioration since the time of injury
- May involve seeking additional information from those close to patient

Determination of need for emergent imaging

- Red flags for intracranial bleed

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

Follow-Up Evaluations



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

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

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

Re-evaluate: Physiologic

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

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

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

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.

Schneider, BJSM, 2017

Targeted Treatments

Cognitive/Fatigue	<ul style="list-style-type: none"> • Difficulty concentrating, overall fatigue, decreased energy levels • Reduce cognitive and physical demands • Regulate sleep, stress, diet, and mild exercise (1 short walk/day)
Vestibular	<ul style="list-style-type: none"> • Dizziness, foginess, nausea, anxiety, overstimulation by complex environments • Brought on with rapid head or body movements • Vestibular rehabilitation
Ocular Motor	<ul style="list-style-type: none"> • 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

Targeted Treatments

Anxiety/Mood	<ul style="list-style-type: none"> • Overall increase in anxiety, perhaps with sleep disturbance and vestibular issues • Treat vestibular issues • Begin physical exertion protocols and regulate sleep
Post-traumatic Migraine	<ul style="list-style-type: none"> • Moderate to severe headache with nausea and photosensitivity or phonosensitivity, often exaggerated by physical activity and stress • Pharmacologic intervention
Cervical	<ul style="list-style-type: none"> • Headache and neck pain • ROM, manual cervical and thoracic mobilization, posture education, biofeedback, soft tissue mobilization

Collins, 2013

X1 Exercises



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

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

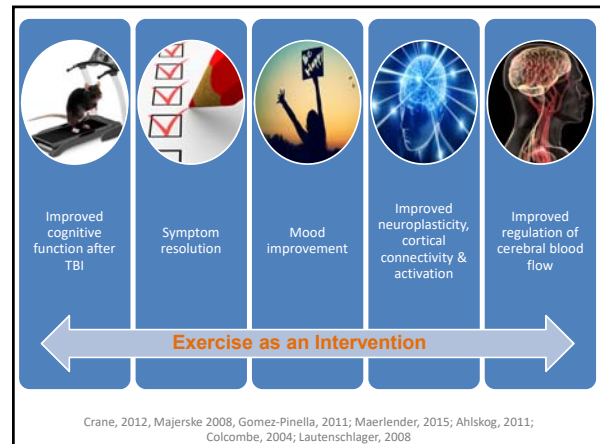
Dual Task Strategies

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

Vestibular Rehabilitation After Concussion

Intervention	Outcomes
<ul style="list-style-type: none"> • Gaze stabilization (X1) • Standing balance • Walking with balance challenges • Canilith repositioning 	<ul style="list-style-type: none"> • ↓ Dizziness rating • ↑ Activities-specific balance confidence scale • ↓ DHI • ↑ Dynamic gait index • ↑ Functional gait assessment • ↓ TUG • ↑ SOT (all conditions)

Alsalaheen, JNPT, 2010



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)

Buffalo Concussion Treadmill Test

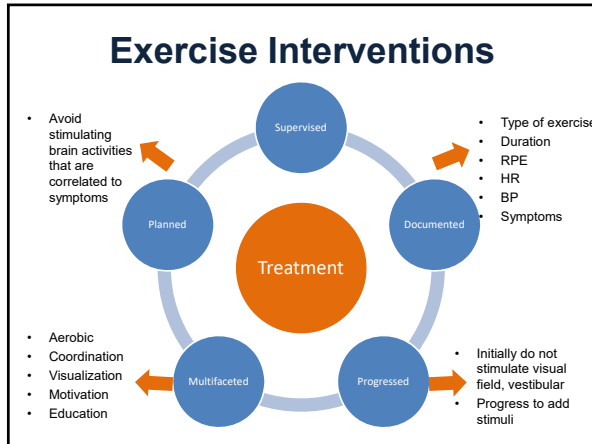
- Good intra-rater reliability and sufficient test-retest reliability (Leddy, 2011)
- Recovery in high school athletes (Darling, 2014)
 - All athletes returned to sport without symptom exacerbation or recurrent symptoms
 - 48% had one or more CNT sub-scores below average
 - BCTT better predicted readiness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

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

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



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

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

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

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

Re-Evaluate: Physiological

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

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

- ### 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

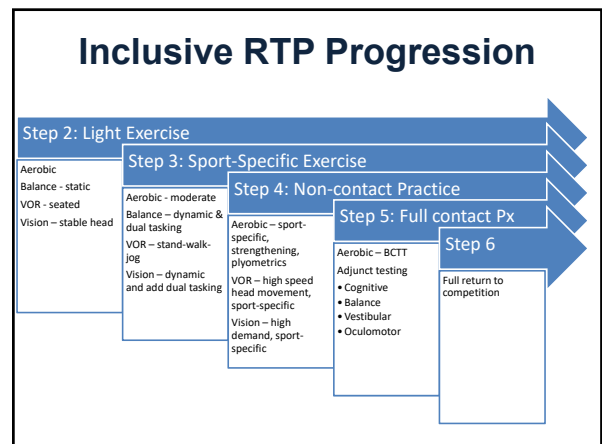
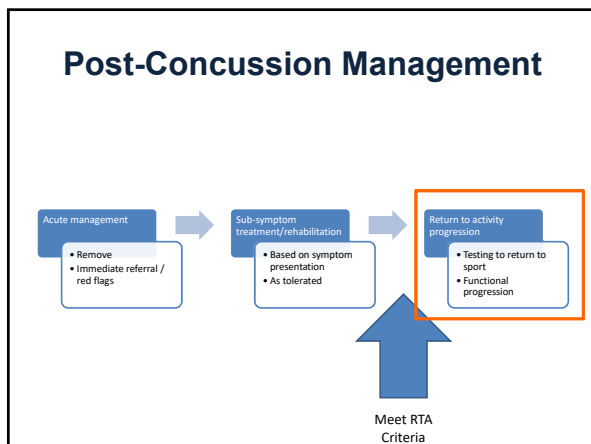
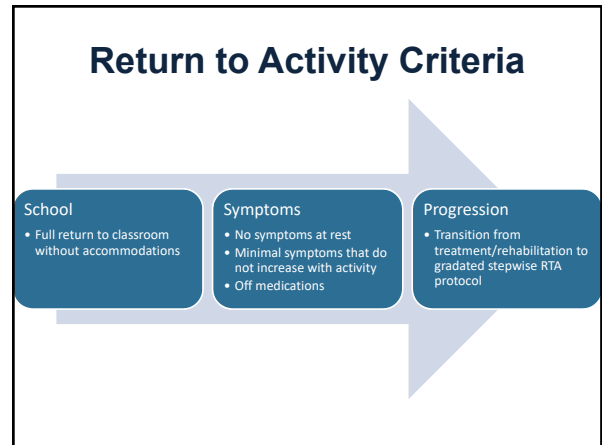
Berlin Progression

Rehabilitation/Treatment

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	Hander 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	Rebuild confidence and assess functional skills by coaching staff
6	Return to sport	Normal game play	

~24 hours between each stage

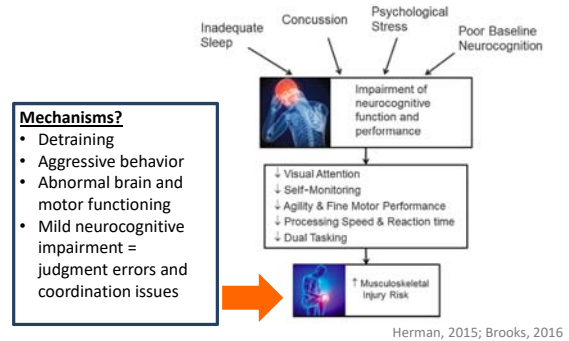
McCrory et al, 2017



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)

Injury After Concussion



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

Reconsider: Elite vs Nonelite

- Should be managed using the same management principles

McCrory et al, Br J Sport Med. 2017

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

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

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)

Return to School Laws

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



Effects of Concussion on Learning

Somatic	Cognitive	Sleep	Emotional
<ul style="list-style-type: none"> • Affects ability to function in class • Unsteadiness • Concentration difficulty 	<ul style="list-style-type: none"> • Difficulty learning and retaining new information 	<ul style="list-style-type: none"> • Results in issues with cognition, behavior, and mood • Decreased alertness in class 	<ul style="list-style-type: none"> • Anxiety can hinder cognition • Adherence to prescribed rest

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)

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

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

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

McCroory et al, Br J Sport Med. 2017

Risk Reduction: PPE

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

McCroory et al, Br J Sport Med. 2017

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 symptoms sustained during both sport and non-sport activity

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?”

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?

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?

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

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

McCrary et al, Br J Sport Med. 2017

Risk Reduction: Prevention

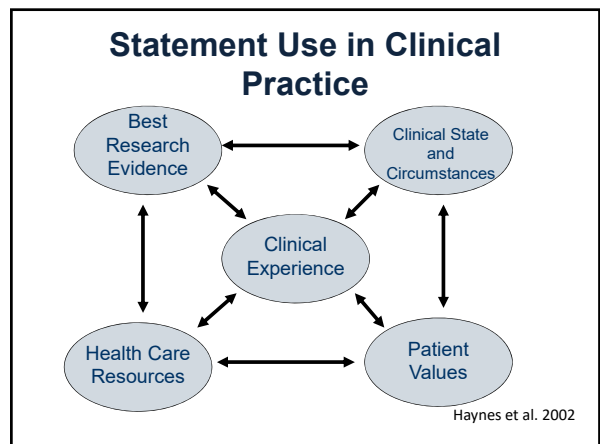
- Promising results
 - Vision training in collegiate American football players may reduce concussion risk
 - Limiting contact in youth football practices has demonstrated reducing the frequency of head contact,
 - No evidence to support the translation of these findings to a reduction in concussions

McCrary et al, Br J Sport Med. 2017

Statement Use in Clinical Practice

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




Statement Similarities

- Clinical diagnosis
- Lack of utility of imaging
- Multifactorial assessment
- No same day return
- Serial monitoring
- Graduated RTP progression

Statement Differences


- Rest vs. Activity
 - Older statements recommend longer rest period
- Treatment
 - More recent statements take active approach
- Neurocognitive Testing
 - NATA statement is the only one that recommends baseline testing

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 postinjury testing not required

Statement Differences: Neurocognitive Testing

AMSSM	AAN	NATA	Berlin
<ul style="list-style-type: none"> • Most can be managed without cognitive testing • Paper and pencil tests can be more comprehensive and assess for other conditions 	<ul style="list-style-type: none"> • Memory, RT, processing speed may be used to identify presence of concussion • Insufficient evidence for use in preadolescent 	<ul style="list-style-type: none"> • Athletes at high risk of concussion should undergo baseline testing • New baseline completed annually for adolescents • Baseline should be multifactorial and include neurocognitive testing 	<ul style="list-style-type: none"> • Aid to clinical decision-making • Computerized tests not substitutes for full NP evaluation • Baseline and postinjury testing not required

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

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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