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Assessment and Management of Pediatric Concussion

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A.T. STILL UNIVERSITY
ARIZONA SCHOOL OF HEALTH SCIENCES | ATSU

Learning Objectives

1. Describe at least two current recommendations for the evaluation of pediatric sport-related concussion.
2. Identify at least three merits of computerized neurocognitive testing among pediatric athletes.
3. List at least three recommended management strategies following concussion.
4. Describe at least three of the recommended return to activity (physical and cognitive) progressions following a concussion.
5. Describe the importance of an interdisciplinary collaborative management team.

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Kinesiology Review, 2015, 4, 131-155
http://dx.doi.org/10.1123/kr.2015-0007

Human Kinetics
ORIGINAL RESEARCH

A Pediatric Perspective on Sport-Related Concussion

Tamara C. Valovich McLeod, Megan N. Houston, and Callee E. Welch

Concussions resulting from sports and recreational activities are a significant concern in the pediatric population. The number of children and adolescents sustaining sport-related concussions is increasing and, as a result, legislation has been passed in all 50 states to ensure appropriate recognition and referral of pediatric athletes following concussion. The developing brain may make the diagnosis, assessment, and management of concussion more challenging for health care providers and requires the use of specific age-appropriate assessment tools. Concussion management must also include considerations for cognitive and physical rest, a collaborative concussion management team that includes medical and school personnel, and more conservative stepwise progressions for returning to school and to physical activity.

Keywords: mild traumatic brain injury, cognitive rest, academic accommodations, neurocognitive assessment, return to activity, return to school

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What is a Concussion

A clinical syndrome of biomechanically induced *alteration of brain function*, typically affecting memory and orientation, which *may* involve loss of consciousness

Giza, AAN, 2013

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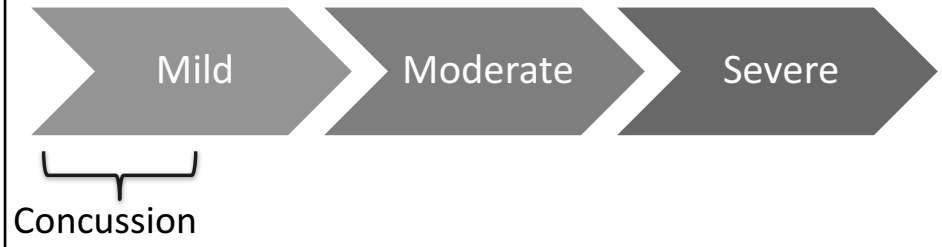
Concussion



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IOM Key Recommendations

Table 1 Key Recommendations from the Institute of Medicine Report on Youth Concussions

Recommendation	Responsible Agency	Recommendation
Recommendation 1	Centers for Disease Control and Prevention	Utilize existing surveillance systems and relevant data to establish and oversee a national system to accurately determine the incidence of sport-related concussion among those ages 5–21
Recommendation 2	National Institutes of Health, Department of Defense	Support research to establish markers of concussion diagnosis, prognosis, and recovery in youth sports and to develop age-specific evidence-based guidelines
Recommendation 3	National Institutes of Health, Department of Defense	Conduct controlled, longitudinal, large-scale studies to assess short and long term effects of concussion
Recommendation 4	National Collegiate Athletic Association, National Federation of State High School Associations, youth sport governing bodies	Evaluate the effectiveness of age-appropriate techniques, rule changes, and playing and practice standards to reduce the risk of concussion
Recommendation 5	National Institutes of Health, Department of Defense	Fund research on age- and sex-related determinants of concussion risk in youth
Recommendation 6	National Collegiate Athletic Association, National Federation of State High School Associations, Centers for Disease Control and Prevention, Health Resources and Services Administration, National Athletic Trainers' Association, Department of Education	Develop, implement, and evaluate the effectiveness of large-scale efforts to improve concussion knowledge and awareness and change the culture

Information adapted from Graham et al., 2014.

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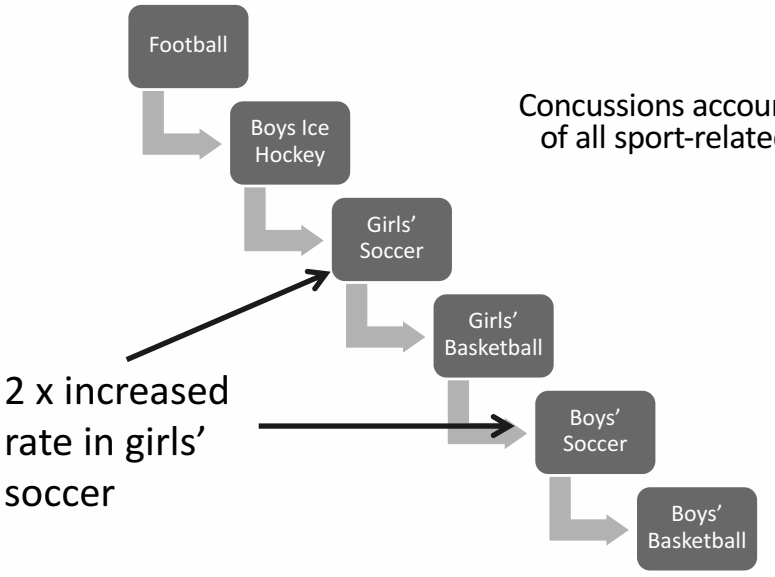
1.1-1.9 million concussions		
Outpatient	ED	School (AT only)
377,000	115-166,000	86,000

Bryan, 2016 9

High School Sports



Concussions account for 8.9% of all sport-related injuries

2 x increased rate in girls' soccer

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Prevention of Concussion

Primary	• Protection from concussion occurring in the first place • Pre-season • Athlete focused
Secondary	• Limiting long-term disability and preventing re-injury • Post-injury • Provider focused
Tertiary	• Aims to soften the impact of an ongoing illness or injury that has lasting effects • Goal is to improve function and quality of life • Post-concussion syndrome

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Understanding Context to Aid Implementation

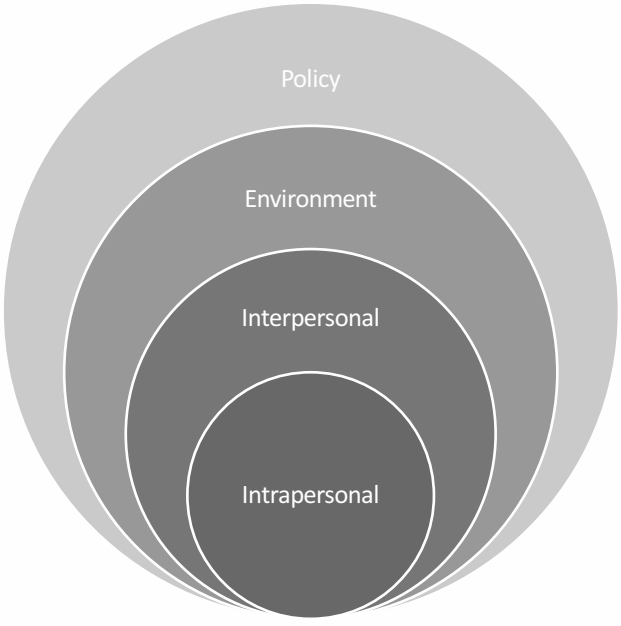
- What are the current safety behaviors and do they need to change?
- What are the motivations and barriers to implementation?
- Knowledge of the safety/injury culture of the sport is important
- Understanding of infrastructure and resources
- Practice-Based Research
- **Public health frameworks can help guide this step**

Finch, 2006 12

Socio-ecological Framework

- Broad perspective that evaluates multiple levels of influences on health behaviors
  - To understand behavior need to consider all levels of the ecological system
  - Also consider the inter-relations and interactions among these levels
  - Examines the cumulative impact of multiple levels of influence,
    - Individual behaviors, peer networks, physical and social environments and relevant policies

Kerr, 2014 13



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Kerr, 2014 14

Comprehensive Coach Education and Practice Contact Restriction Guidelines Result in Lower Injury Rates in Youth American Football

Zachary Y. Kerr,* PhD, MPH, Susan Yeargin,† PhD, ATC, Tamara C. Valovich McLeod,‡ PhD, ATC, FNATA, Vincent C. Nittoli,§ MS, ATC, James Mensch,† PhD, ATC, Thomas Dodge,‖ PhD, ATC, Ross Hayden,* MA, and Thomas P. Dompier,* PhD, ATC

Investigation performed at Datalys Center for Sports Injury Research and Prevention, Indianapolis, Indiana, USA

Lower injury rates in practice and games with HUF and contact restrictions

Lower concussion rates in practice among 11-15 year olds

Comprehensive Coach Education Reduces Head Impact Exposure in American Youth Football

Zachary Y. Kerr,*† PhD, MPH, Susan W. Yeargin,† PhD, ATC, Tamara C. Valovich McLeod,‡§ PhD, ATC, FNATA, James Mensch,† PhD, ATC, Ross Hayden,† MA, and Thomas P. Dompier,† PhD, ATC

Investigation performed at Datalys Center for Sports Injury Research and Prevention Inc, Indianapolis, Indiana, USA

Athletes in HUF leagues accumulated fewer head impacts per practice at both 10g and 20g thresholds

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Knowledge and Recognition Issues

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Concussion Recognition Problems

Medical Professionals
- Hospital discharge (Genuardi & King, 1995)
- MDs, NPs (Bazarian, 2001; Zonfillo, 2012; White 2013; Stoller, 2014, Carl, 2014)
- Primary Care (Pleacher & Dexter, 2006; Lebrun, 2013)

Coaches
- High school (O'Donoghue, 2009)
- Youth (Valovich McLeod, 2007, Mrazik, 2011)

Athletes
- College (Kaut, 2003; LaBotz, 2004)
- High school (McCrea, 2004; Valovich McLeod, 2006; Sye, 2006; Register-Mihalik, 2013; Cournoyer, 2015; Delahunty, 2015Kurowski, 2014)
- Youth (Williamson, 2006; Gourley, 2010)

Parents
- Youth (Sullivan, 2009; Gourley, 2010; Stevens 2010; Lin, 2015)

Concussion Reporting Barriers

- Athletes know concussions are dangerous
- Most would still play with symptoms
- Athletes want to keep playing
- It's hard to tell if you are injured
- You're supposed to play injured
- Don't want to let team down
- Hesitant to report to coach

Chrisman, 2012

ATSU

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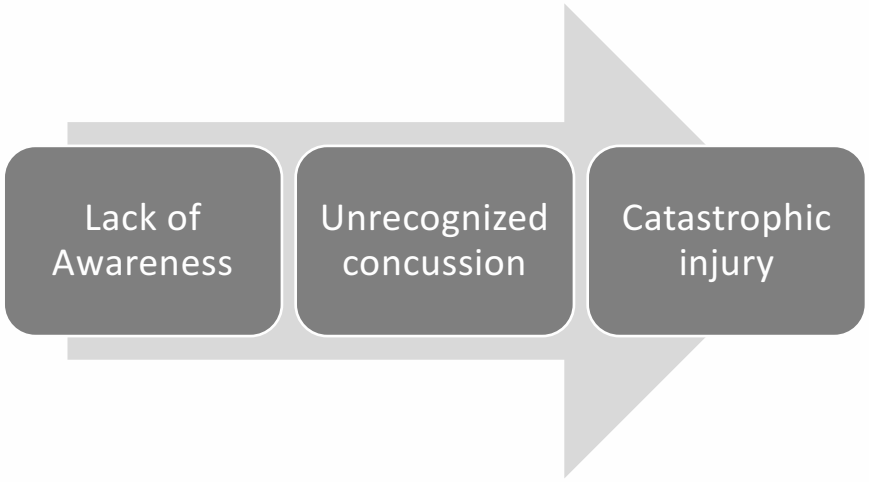
The Problem



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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

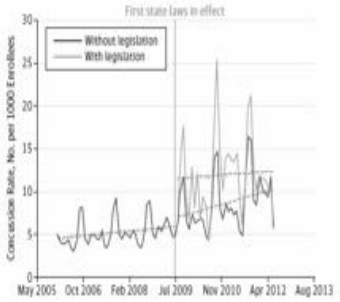

Table 1. States With Concussion Legislation in Effect by Year of Implementation

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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Education

- State Laws
  - All require some form of education
  - Varies as to whom and how often
- Interscholastic Association: Parent/Athlete
  - Majority (n=30) use information handouts
  - 2 require online training (AZ, OR)
  - 2 refer to CDC web training (GA, IL)
  - 3 encourage NFHS training (RI, VA, WI)
- Interscholastic Association: Coach
  - Most require NFHS training for head coaches

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Education

Table 2 Concussion Education Programs for Pediatric Stakeholders

Education Program	Targeted Stakeholders	URL
CDC Heads Up	Youth sport coaches, high school coaches, parents, youth and high school athletes, health care providers, school personnel	www.cdc.gov/headsup/
Barrow BrainBook	High school athletes	www.craniumcommons.com/bb/
Brain 101: The Concussion Playbook	Coaches	http://brain101.orcasinc.com/4000/
	Educators	http://brain101.orcasinc.com/2000/
	Parents	http://brain101.orcasinc.com/3000/
	Teen athletes	http://brain101.orcasinc.com/5000/
National Federation of State High School Associations	High school coaches, parents, high school athletes, officials, administrators	https://nfhslearn.com/courses/38000
Sports Legacy Institute Community Educators (SLICE)	Student-athletes (grades 4–12)	www.sportslegacy.org/education/slice/
ThinkFirst	Schools, community groups	www.thinkfirst.org/concussion

Valovich McLeod, Kinesiology Reviews, 2015 24

Effect of Educational Intervention

- **Improved immediate knowledge**
  - Cook, 2003
  - Goodman, 2006
  - Glang, 2010
  - Koh, 2011
  - Bagley, 2012
  - Miyashita, 2013
  - Manasse-Cohick, 2014
  - Cusimano, 2014
  - Hunt, 2015
- **No effect on knowledge**
  - Echlin, 2010
  - Kroshus, 2013
  - Cusimano, 2014
  - Manasse-Cohick, 2014
  - Register-Mihalik, 2015
  - Register-Mihalik, 2015

Increase in immediate knowledge in some studies but the long-term effects of interventions on retention and reporting behaviors are unclear (Caron, 2015)

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Effects of Concussion Education

- Knowledge is improving (Chrisman, 2012; Bloodgood, 2013)
  - Concussion symptom video game improved identification in youth hockey players (Goodman, 2006)
- Intent to report remains problematic (Chrisman, 2013; Register-Mihalik, 2013; Mrazik, 2014; Rivara, 2014)
  - Concussion education increased reporting of concussion symptoms to coaches (Bramley, 2012)
  - Increased perceptions of *unsafe* reporting behaviors in group who watched hockey video (Kroshus, 2014)
  - No changes in attitudes, norms or behavioral intentions following education (Kroshus, 2013)

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Developing Effective Education: What Do Athletes Want?

- Content
  - Symptoms
  - Proper management
  - Long-term issues
  - Impact on athletic performance
  - Impact on academics
  - Importance of self-reporting
- Mode of Delivery
  - Lecture (57%)
  - Video (54%)
  - Handout (28%)
- 40% want education provided by **coach**

Kroshus, 2015 27

Concerns with the Developing Brain

Vulnerability

- Nervous system immaturity
- Decreased myelination
- Greater head-to-body ratio
- Thinner frontal and temporal cranial bones
- Periods when the brain is more susceptible to injury and recovery is more difficult

Aldrich et al, 1992; Giza & Hovda, 2000; Kraus et al, 1986; Prins & Hovda, 1998; Theye & Mueller, 2004

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Metabolic Differences

- Differences in $lCMR_{gluc}$ between children $\leq$15 years and adults
- Children are at a greater risk for secondary ischemia
- Diffuse and more prolonged cerebral swelling

Bruce et al, 1981; Capruso & Levin, 1996; Chugani et al, 1991; Chugani et al, 1987; Field et al, 2003; Lazar et al, 1997; Prins & Hovda, 1998; Schnitker, 1949; Snoek et al, 1984

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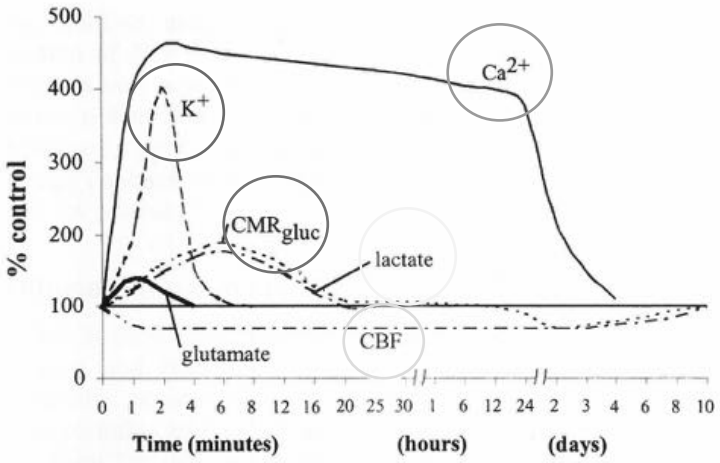

Figure 1. Neurometabolic cascade following experimental concussion. K^+, potassium; Ca^{2+}, calcium; CMRgluc, oxidative glucose metabolism; CBF, cerebral blood flow. (Reprinted with permission. Giza CC, Hovda DA. Ionic and metabolic consequences of concussion. In: Cantu RC, Cantu RI. *Neurologic Athletic and Spine Injuries.* St Louis, MO: WB Saunders Co; 2000:80–100.).

Giza & Hovda, *J Athl Train*, 2001.

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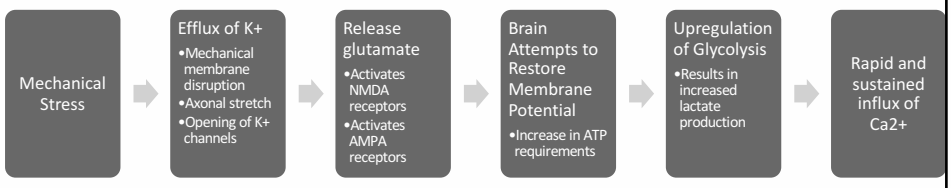

- Cerebral blood flow is decreased (for several days
 = Mismatch between glucose delivery and glucose consumption
  -Could predispose to secondary injury
-Increase $lCMR_{gluc}$ initially, then falls below normal
  ? Vulnerability to secondary injury

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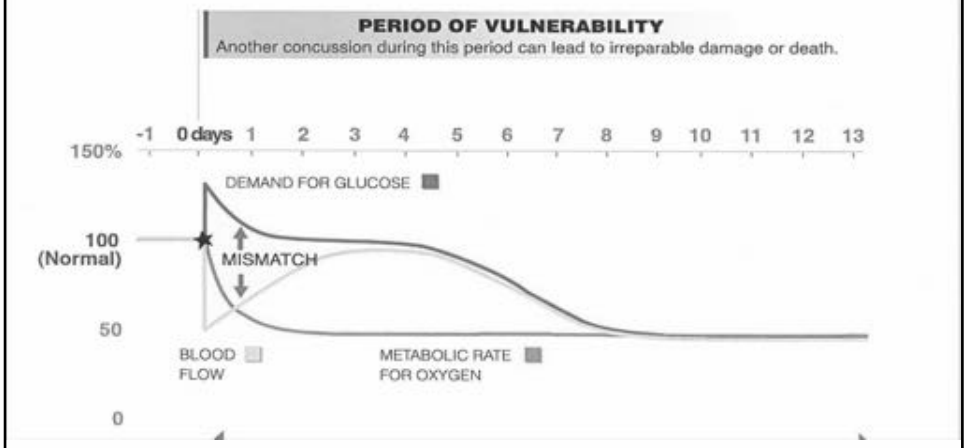

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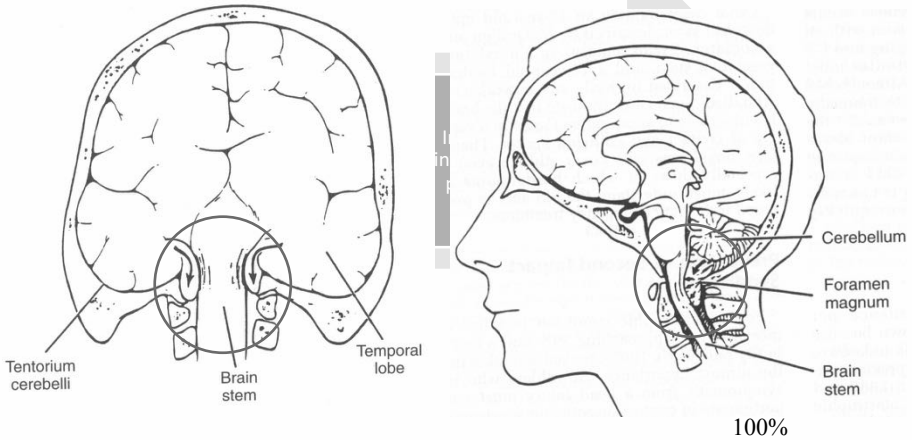
Pathophysiology of SIS



100%

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Malignant Brain Edema Syndrome

- Condition found in pediatric athletes
- Consists of rapid neurologic deterioration from an alert conscious state to coma and sometimes death, minutes to several hours after head trauma
- Result of diffuse brain swelling with little or no brain injury
  - Diffuse cerebral swelling from hyperemia or vascular engorgement

Bruce et al. *J Neurosurg,* 1981; Cantu, *Adolesc Med,* 1991

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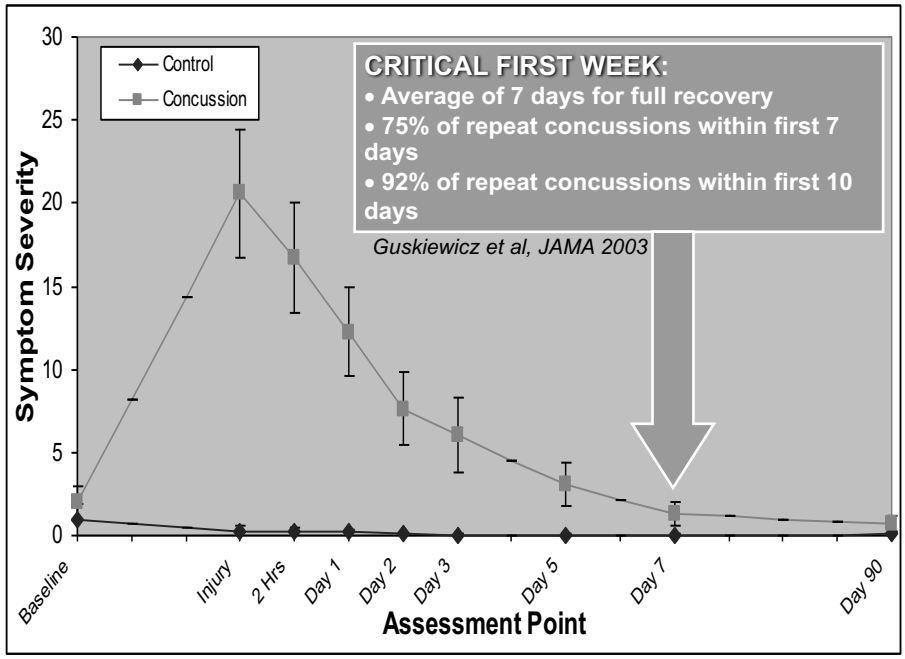

Courtesy of Kevin M. Guskiewicz, PhD, ATC

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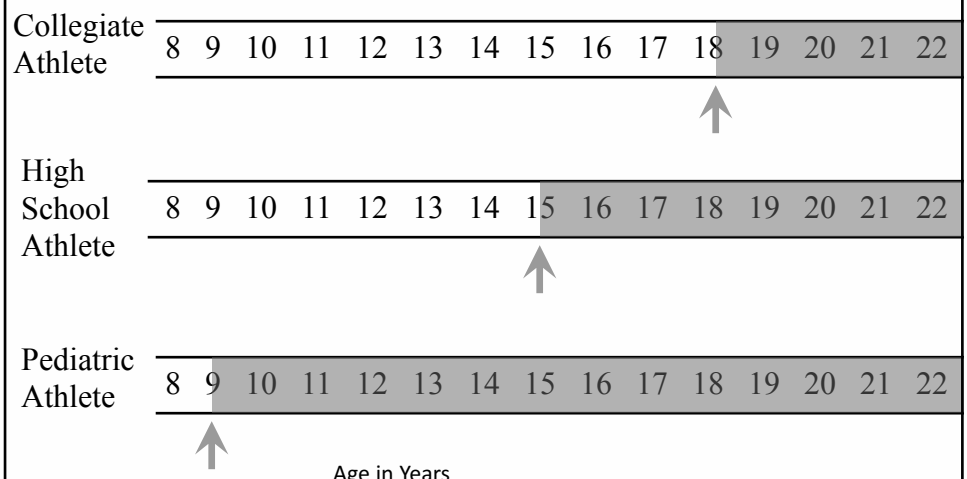
Window of Opportunity for Repeat Injuries



Guskiewicz & Valovich McLeod, 2011

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Repeat Concussion

- 4-6 times ↑ risk for subsequent concussion (Gerberich et al, 1983; Wilberger, 1993; Zemper, 1994)
- 3 times more likely to sustain 2nd in same season (Guskiewicz et al, 2000)
- Increased severity with subsequent concussion (Guskiewicz et al, 2000)

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Repeat Concussion

- Risk of incident concussion:
  - Players with 3+ previous concussions, are 3.5x (95%CI:1.8-6.5) more susceptible to concussion than a player with no concussion history
  - Players with 2 previous: 2.8x (95%CI: 1.6-4.7) risk
  - Players with 1 previous: 1.5x (95%CI: 1.0-2.1) risk

Guskiewicz et al, JAMA 2003

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Cumulative Effects

Cognitive

- College FB with **2+** prior concussions performed worse on cognitive tests (Collins, 1999)

Symptoms

- **3+** previous concussions reported more headaches, memory problems, and taking longer to think (Gaetz et al, 2000)

Other

- College athletes with **3+** had lower vitality, bodily pain, social functioning, greater impact of headache (Kuehl, 2010)
- Concussion history associated with depression and MCI (Guskiewicz, 2005, 2007)
- Chronic Traumatic Encephalopathy (McKee, 2009)

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Age & Recovery

Authors	Sample Size	Population	Tests Utilized	Total Days Cognitive Resolution	Total Days Symptom Resolution	Individual Recovery Rates
McCrea et al. 2003	94	College	Paper and Pencil	3-5 Days	7 Days	91% recovered w/in 7 days
Iverson et al. 2006	30	High School	Computer ImPACT	10 days	7 Days	50% recovered w/in 7 days
Collins Lovell, et al. 2006	134	High School	Computer ImPACT	NR	NR	40% recovered w/in 7 days

Slide Courtesy of Gerry Gioia, PhD

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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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Assessment and Evaluation

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Pre-Participation Examination

- Important element of high school athletic participation
  - required in 50 of 51 jurisdictions at the high school level (Caswell et al., 2015)
- Significant variability in youth and community sports
- May be a missed opportunity for HCPs to identify pediatric athletes with histories of prior concussions or comorbid factors that may influence concussion recovery

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Pre-Participation Examination

- Can assist clinicians in establishing (McLeod, 2015):
  - An accurate prior concussion history
  - Identifying risk factors that may increase the individual's risk of sustaining a concussion or having a prolonged recovery
  - Educating the patient and parent regarding concussion risk

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

NextCare URGENT CARE The Preferred Health Care Partner of the Arizona Interscholastic Association

2017-2018 ANNUAL PREPARTICIPATION PHYSICAL EVALUATION

(The Parent or Guardian should fill out this form with assistance from the student athlete.) Exam Date:

23) Have you ever had an injury to your face, head, skull or brain (including a concussion, confusion, memory loss or headache from a hit to your head, having your "bell rung" or getting "dinged")?	☐	☐
24) Have you ever had a seizure?	☐	☐
25) Do you have headaches with exercise?	☐	☐
26) Have you ever had numbness, tingling, or weakness in your arms or legs after being hit, falling, stingers or burners?	☐	☐

http://aiaonline.org/files/10800/form-157-a-annual-preparticipation-physical-evaluation.pdf

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Development & Management

Table 2. *Age range and developmental stages in management of concussion**

Age Range	Developmental Stage	Challenge to Concussion Management	Potential Clinical Approach
Pre-adolescence (6-11 y)	Short attention span, high distractability, limited ability to plan in accordance with potential consequences to actions	Difficult to relate the importance of adherence to treatment	Involve parent, siblings, and other adults to reinforce recommendations; frequent follow-up
Early adolescence (12-14 y)	Concrete thinking, narcissistic-type concern for one's appearance and social status	Under-reporting of symptoms, poor compliance with plans	Involve parents and coaches
Middle adolescence (15-16 y)	Working toward independence and separation from parents, typically understand potential consequences for noncompliance	May be highly motivated to return to play for the sake of peer acceptance; may lead to underreporting	Establish rapport with patient and accurately relate potential outcomes of noncompliance
Late adolescence (17-19 y)	Abstract thinking and comprehension for potential long-term consequences have developed	Improved compliance with treatment recommendations; maybe less parental involvement with older teens	Accurately relate the potential consequences and importance of compliance

*Adapted from [1,91].

Karlin, 2011

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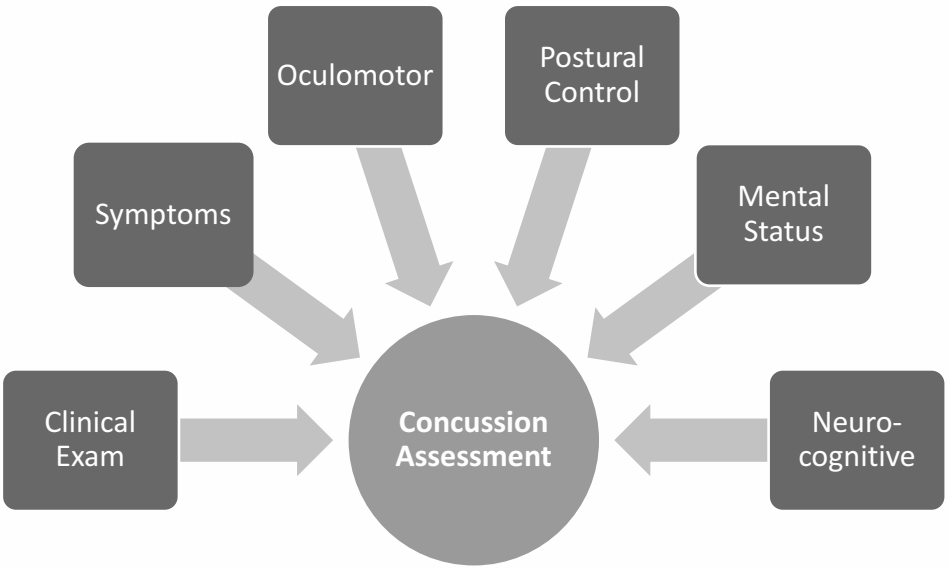

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SCAT2

Sport Concussion Assessment Tool 2

Overall score

Test domain	Score
Symptom score	of 22
Physical signs score	of 2
Glasgow Coma score (E + V + M)	of 15
Balance examination score	of 30
Coordination score	of 1
Subtotal	**of 70**
Orientation score	of 5
Immediate memory score	of 5
Concentration score	of 15
Delayed recall score	of 5
SAC subtotal	**of 30**
SCAT2 total	**of 100**
Maddocks Score	**of 5**

- Total points = 100
  - Adolescent baseline = 88.3±6.8 (range=58-100)
  - Day of injury = 79.4±9.2*
  - Day 3 post-injury = 83.8±9.1*
  - Day 10 post-injury = 91.3±7.3

Valovich McLeod, *AJSM* 2012; Purdoff *JAT*, 2011

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Child SCAT3

- The Child-SCAT3 self-report symptom checklist may be inappropriate to administer to younger school-aged children
- Age effects observed warrant use of demographically appropriate norms

(Nelson, 2016)

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- Sideline Assessment
  - Indications for immediate referral
  - Glasgow Coma Scale
  - Potential signs of concussion
  - Modified Maddocks' questions

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- Background
  - Parent questionnaire
    - Prior concussion history
    - Past medication and imaging history
    - Comorbid factors

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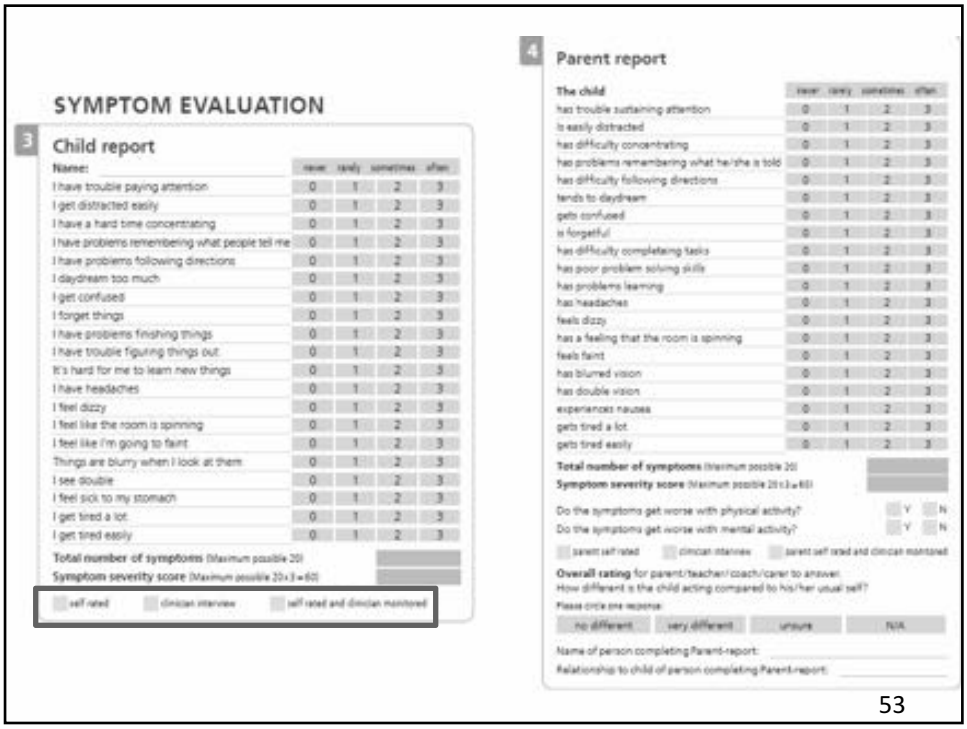

SYMPTOM EVALUATION

3 Child report

Name:	never	rarely	sometimes	often
I have trouble paying attention	0	1	2	3
I get distracted easily	0	1	2	3
I have a hard time concentrating	0	1	2	3
I have problems remembering what people tell me	0	1	2	3
I have problems following directions	0	1	2	3
I daydream too much	0	1	2	3
I get confused	0	1	2	3
I forget things	0	1	2	3
I have problems finishing things	0	1	2	3
I have trouble figuring things out	0	1	2	3
It's hard for me to learn new things	0	1	2	3
I have headaches	0	1	2	3
I feel dizzy	0	1	2	3
I feel like the room is spinning	0	1	2	3
I feel like I'm going to faint	0	1	2	3
Things are blurry when I look at them	0	1	2	3
I see double	0	1	2	3
I feel sick to my stomach	0	1	2	3
I get tired a lot	0	1	2	3
I get tired easily	0	1	2	3

Total number of symptoms (Maximum possible 20)

Symptom severity score (Maximum possible 20 x 3 = 60)

self rated clinician interview self rated and clinician monitored

4 Parent report

The child	never	rarely	sometimes	often
has trouble sustaining attention	0	1	2	3
is easily distracted	0	1	2	3
has difficulty concentrating	0	1	2	3
has problems remembering what he/she is told	0	1	2	3
has difficulty following directions	0	1	2	3
tends to daydream	0	1	2	3
gets confused	0	1	2	3
is forgetful	0	1	2	3
has difficulty completing tasks	0	1	2	3
has poor problem solving skills	0	1	2	3
has problems learning	0	1	2	3
has headaches	0	1	2	3
feels dizzy	0	1	2	3
has a feeling that the room is spinning	0	1	2	3
feels faint	0	1	2	3
has blurred vision	0	1	2	3
has double vision	0	1	2	3
experiences nausea	0	1	2	3
gets tired a lot	0	1	2	3
gets tired easily	0	1	2	3

Total number of symptoms (Maximum possible 20)

Symptom severity score (Maximum possible 20 x 3 = 60)

Do the symptoms get worse with physical activity? Y N

Do the symptoms get worse with mental activity? Y N

parent self rated clinician interview parent self rated and clinician monitored

Overall rating for parent/teacher/coach/carer to answer:
How different is the child acting compared to his/her usual self?
Please circle one response:

no different very different unsure N/A

Name of person completing Parent-report:

Relationship to child of person completing Parent-report:

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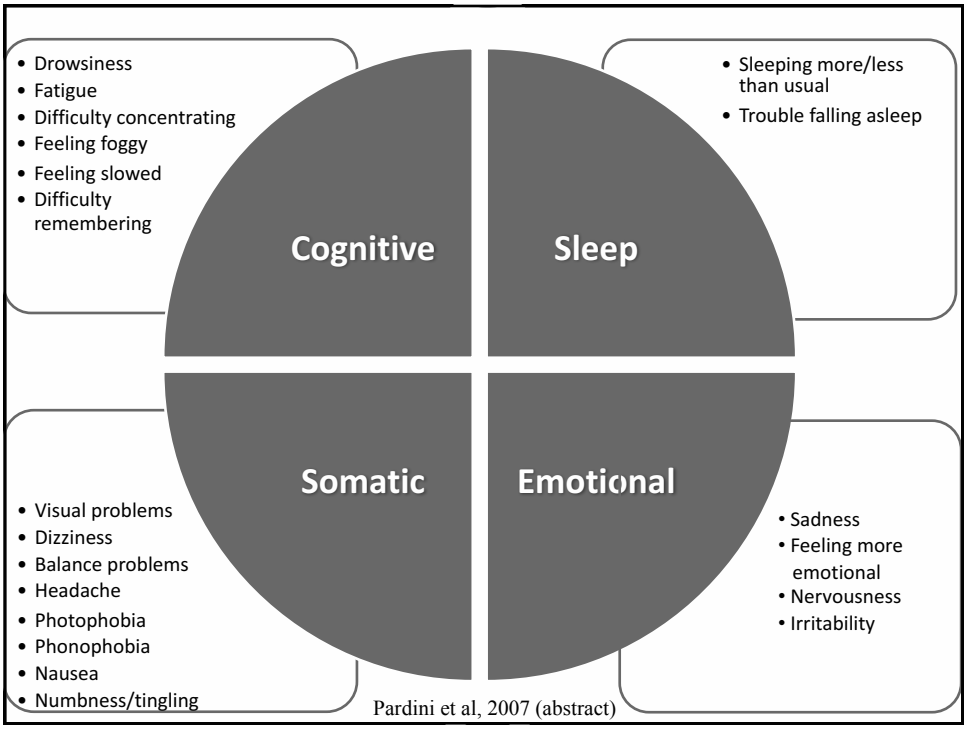
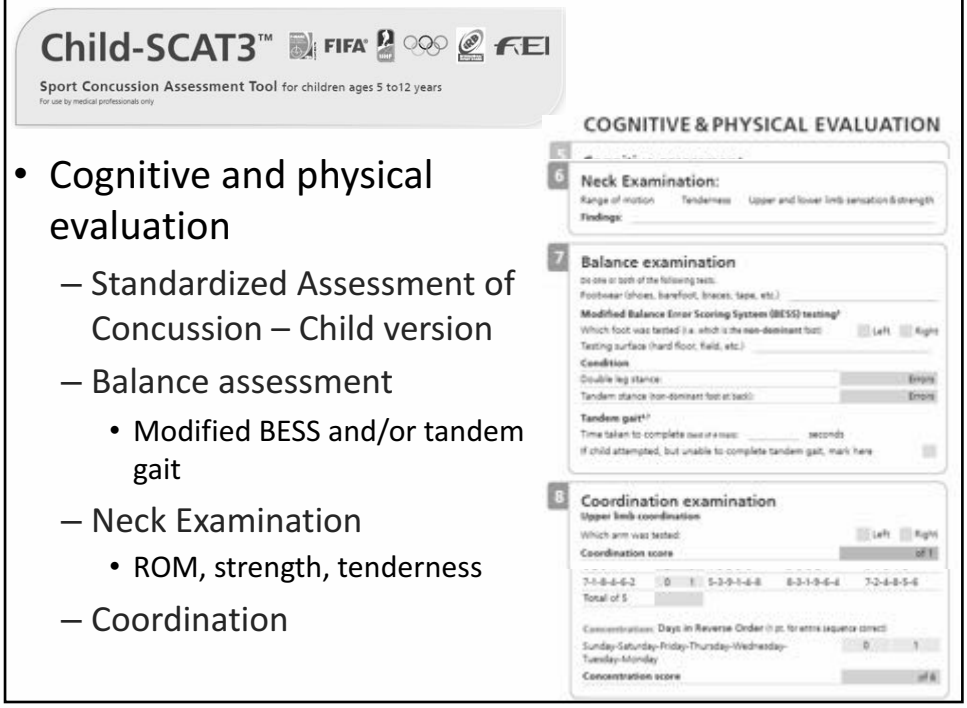


Pardini et al, 2007 (abstract)

- Cognitive and physical evaluation
  - Standardized Assessment of Concussion – Child version
  - Balance assessment
    - Modified BESS and/or tandem gait
  - Neck Examination
    - ROM, strength, tenderness
  - Coordination


Child-SCAT3™ FIFA FEI

Sport Concussion Assessment Tool for children ages 5 to12 years

For use by medical professionals only

COGNITIVE & PHYSICAL EVALUATION

6 Neck Examination:

Range of motion Tenderness Upper and lower limb sensation & strength

Findings:

7 Balance examination

Do one or both of the following tests:

Footwear (shoes, barefoot, braces, tape, etc.)

Modified Balance Error Scoring System (BESS) testing²

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

Testing surface (hard floor, field, etc.)

Condition

Double leg stance: Errors

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

Tandem gait³⁴

Time taken to complete (best of 4 trials): seconds

If child attempted, but unable to complete tandem gait, mark here

8 Coordination examination

Upper limb coordination

Which arm was tested: Left Right

Coordination score of 1

7-1-8-4-6-2 0 1 5-3-9-1-4-8 8-3-1-9-6-4 7-2-4-8-5-6

Total of 5

Concentration: Days in Reverse Order (1 pt. for entire sequence correct)

Sunday-Saturday-Friday-Thursday-Wednesday-Tuesday-Monday 0 1

Concentration score of 1

Balance Assessment

- Heel to opposite knee
- Finger to nose
- Romberg test

Difficult to quantify and use in serial assessments

- Computerized posturography (SOT, CTSIB)
- Clinical balance tests (BESS, SEBT)
- Functional balance tests (TUG, Gait)

56

Neurocognitive Testing

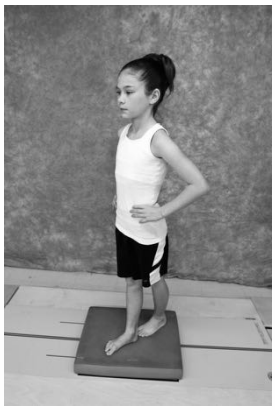
AMSSM	AAN	Zurich	NATA
• Most can be managed without cognitive testing • Paper and pencil tests can be more comprehensive and assess for other conditions	• Memory, RT, processing speed may be used to identify presence of concussion • Insufficient evidence for use in preadolescent	• Clinical value and contributes significant information post-injury • Insufficient evidence for widespread use of routine baseline testing • Timing may be different in pediatric for return-to-learn	• Athletes at high risk of concussion should undergo baseline testing • New baseline completed annually for adolescents • Baseline should be multifactorial and include neurocognitive testing

57

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

Clinical Tests of Vestibular Function

- Interview / patient history
- Oculomotor screening
  - Smooth pursuits
  - Saccades
  - Gaze stability
- SCC and otoliths
  - Head shake/thrust
  - Dynamic visual acuity
- Functional tests
  - Gaze stability
  - Balance



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Initial Management and Treatment

59

Concussion Effects

Acute

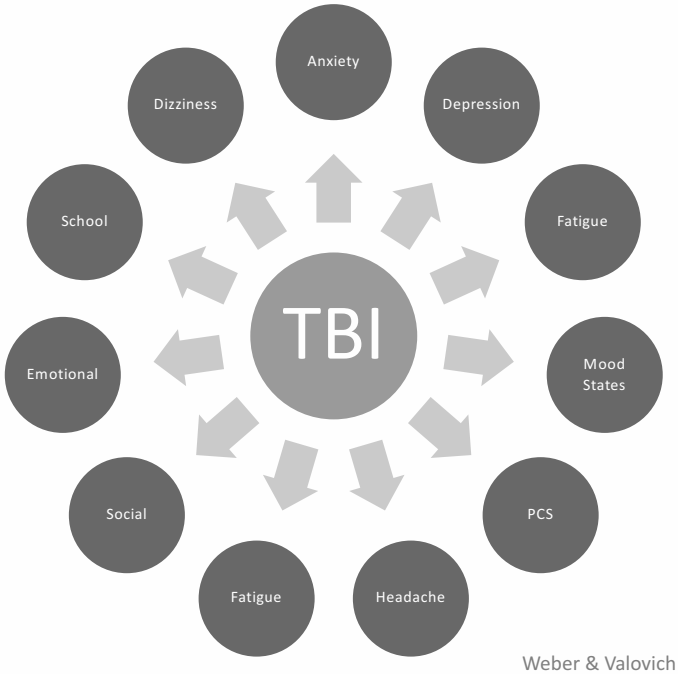
- ↑Symptoms
- Impaired Cognition
- Impaired Balance

Chronic

- ? Association to Depression
- ? Association to MCI
- Chronic Traumatic Encephalopathy

Quality of Life

60



61

Weber & Valovich McLeod, 2015

How Are Concussions Managed?

REST

- Physical Rest
- Cognitive Rest

62

Treatment and Rehabilitation

- Rest vs activity
- Exercise Progression
- Vestibular and Ocular Therapy
- Dual Tasking

63

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

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?
3. How compliant are healthcare providers in following current return-to-activity guidelines?
4. How effective are the graded return-to-activity protocols in improving patient outcomes following concussion?

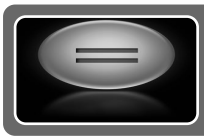
Study	Key Results
Arbogast, 2013	62% of physicians described awareness of CR as part of management; only 2.4% described CR in detail 11% of charts reviewed included written CR recommendations
Carson, 2014	Worsening of symptoms in 44.7% of patients following premature RTL Patients with prior history of 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

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

Effectiveness of Rest

3 studies showing too much activity delayed recovery = worse outcomes

2 studies show rest improves outcomes



4 studies found no association between rest and outcomes

1 study found strict rest resulted in a longer recovery

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

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

Majerske, *JAT*, 2008

Improved cognitive function after TBI

Symptom resolution

Mood improvement

Improved neuroplasticity, cortical connectivity & activation

Improved regulation of cerebral blood flow

Exercise as an Intervention

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

68

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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Figure 2. Schematic representation of the MCH-RAC programme.

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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

73

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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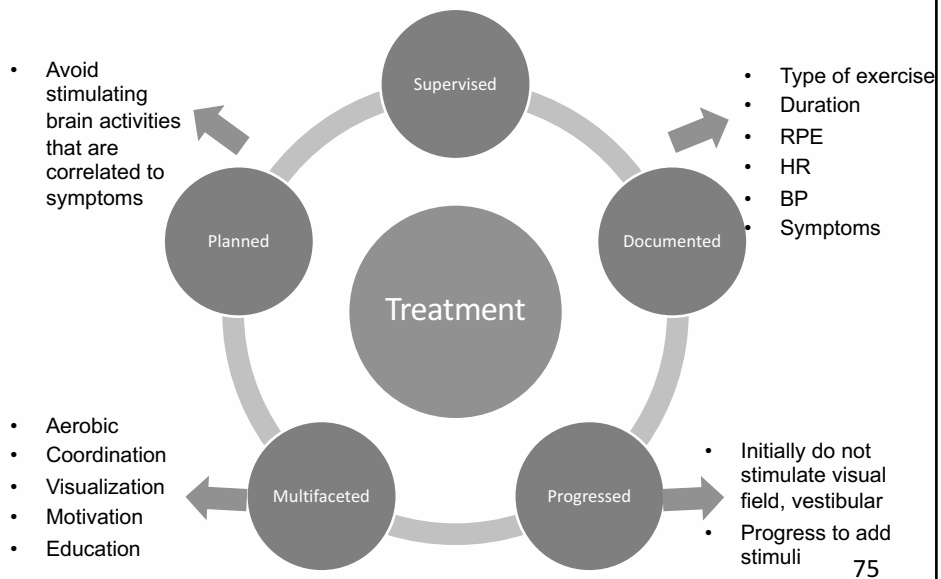
Exercise Interventions



75

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

- Physical and cognitive rest is underutilized by healthcare providers (Strength of Recommendation = B)
- Moderate physical and cognitive rest may facilitate recovery during the initial days after concussion (Strength of Recommendation = B)
- Significant variability in the use of assessment tools and compliance with recommended return-to-activity guidelines exists (Strength of Recommendation = B)
- There is little evidence to support the effectiveness of the graded return-to-activity progression (Strength of Recommendation = D)

Treatment

- Vestibular suppressants (short term basis)
  - Anticholinergics
  - Antihistamines
  - Benzodiazapines
- Balance Rehabilitation Therapy (BRT)
  - Vestibular rehabilitation

Henrie & Elovic. Somatic Manifestations of mTBI. In: *Manual of TBI Management*, 2011.

77

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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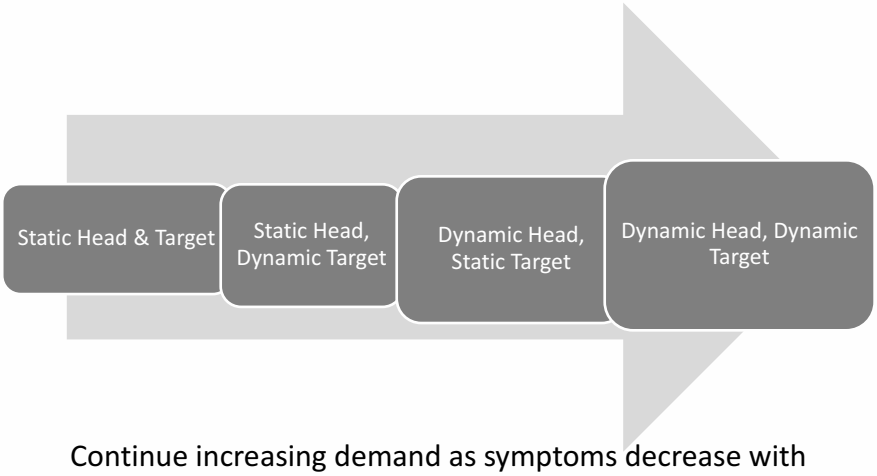
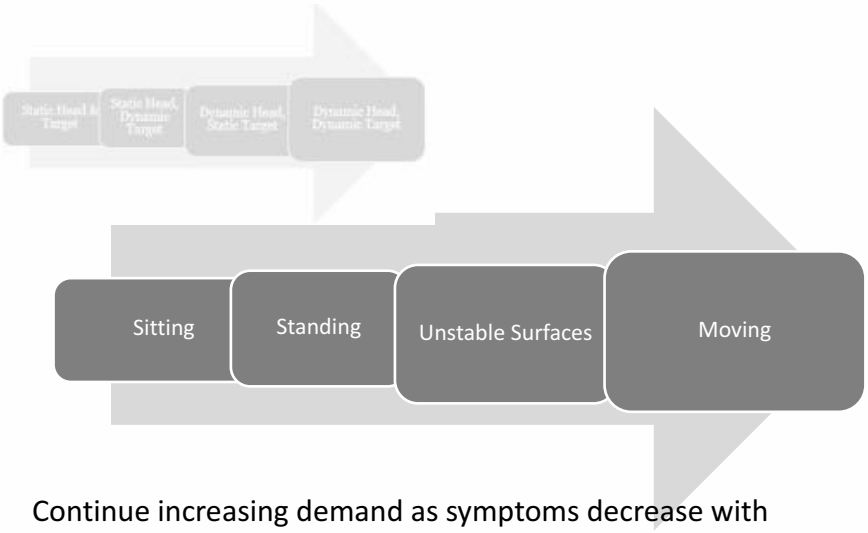
STEP WISE APPROACH: Visual-Vestibular



Continue increasing demand as symptoms decrease with each new demand.

Courtesy of Bridgett Wallace PT Presentation 2016

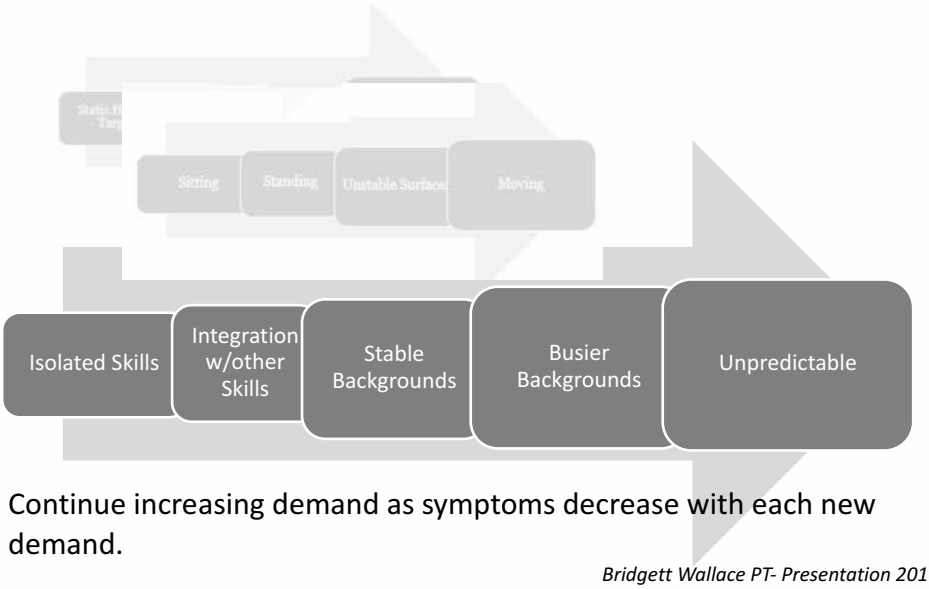
STEP WISE APPROACH: Visual-Vestibular



Continue increasing demand as symptoms decrease with each new demand.

Bridgett Wallace PT Presentation 2016

STEP WISE APPROACH: Visual-Vestibular



Continue increasing demand as symptoms decrease with each new demand.

Bridgett Wallace PT- Presentation 2016

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 Exercise Progressions





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Oculomotor Disorder

- Evaluation
  - VOMS
  - King-Devick
  - Referral to neuro-optometrist or ophthalmologist
- Treatment
  - Oculomotor retraining / rehabilitation
- Prevention
  - Pre-season vision training
  - Exploratory study out of University of Cincinnati shows decrease in concussion rate (9.2 vs. 1.4 concussion/100 player seasons) after preseason vision training (Clark, 2015)

85

Oculomotor Disorder

- Symptoms (Ciuffreda, 2011)
  - Difficulty reading, dizziness, headaches, ocular pain, poor visual based concentration
  - End of day fatigue
- Family History of lazy eye, nystagmus
- May manifest into poor academic/work performance, motion sensitivity/car sickness (Collins, 2014)

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Return to School

87

Effects of Concussion on Learning

Somatic	Cognitive	Sleep	Emotional
• Affects ability to function in class	• 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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TABLE 1 Signs and Symptoms of a Concussion and the Potential Problems They May Pose to the Student

Sign/Symptom	Potential Implications in School
Headache	Most common symptom reported in concussions
	Can distract the student from concentration
	Can vary throughout the day and may be triggered by various exposures, such as fluorescent lighting, loud noises, and focusing on tasks
Dizziness/lightheadedness	May be an indication of injury to vestibular system
	May make standing quickly or walking in crowded environment challenging
	Often provoked by visual stimulus (rapid movements, videos, etc)
Visual symptoms: light sensitivity, double vision, blurry vision	Troubles with various aspects of the school building
	Slide presentations
	Movies
	Smart boards
	Computers
	Handheld computers (tablets)
	Artificial lighting
	Difficulty reading and copying
	Difficulty paying attention to visual tasks
Noise sensitivity	Troubles with various aspects of the school building
	Lunchroom
	Shop classes
	Music classes (band/choir)
	Physical education classes
	Hallways
	Organized sports practices
Difficulty concentrating or remembering	Challenges learning new tasks and comprehending new materials
	Difficulty with recalling and applying previously learned material
	Lack of focus in the classroom
	Troubles with test taking
	Troubles with standardized testing
	Reduced ability to take drivers education classes safely
Sleep disturbances	Excessive fatigue can hamper memory for new or past learning or ability to attend and focus
	Insufficient sleep can lead to tardiness or excessive absences
	Difficulty getting to sleep or frequent waking at night may lead to sleeping in class
	Excessive napping due to fatigue may lead to further disruptions of the sleep cycle

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Halstead, *Pediatr*, 2013

Effects of Learning on Concussion

- Engaging in cognitive activity may provide added stress to an under-energized brain
- Symptoms worsen following cognitive activity
  - Cognitive overexertion (exertion effect)
  - 88.5% of girls and 55.4% of boys experience CEE after concussion (Gioia, unpublished)

90

Concussion and the Classroom

The Academic Fallout Of Teen Athlete Concussions

by TOM GOLDMAN

May 19, 2010

text size A A A

Most of the discussion on concussions in sports has focused on professional athletes -- mainly foot
how there need
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examining what
student athlete.

Cognitive Rest: The Often Neglected Aspect of Concussion Management

Tamara C. Valovich McLeod, PhD, ATC • A.T. Still University and Gerard A. Gioia, PhD • Children's National Medical Center

Athl Ther Today, 2010

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Journal of Athletic Tr
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www.nata.org/jat

Communications

Supporting the Student-Athlete's Return to the Classroom After a Sport-Related Concussion

Neal McGrath, PhD

Sports Concussion New England, Brookline, MA

91

Academic Decline

- 79% of athletic trainers in high schools have <u>personally</u> encountered a situation where a student athlete has experienced a <u>decrease in school and academic performance</u> as a direct result of a symptomatic concussion
- ~44% of concussions resulted in some form of academic accommodations

Williams, *J Athl Train*, 2015

92

Impact of Time Loss on HRQOL

- Time loss from sports participation is significantly associated with lower HRQOL
- Strongest associations at Days 3 and 10
  - When most athletes are withheld from competition and may still be experiencing symptoms
- **Time loss following a concussion was most strongly related to <u>school</u> functioning**

Valovich McLeod, IBIA, *Brain Inj,* 2012 (abstract)

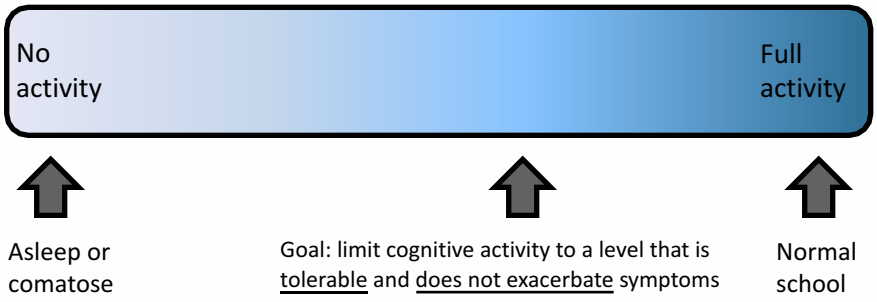
93

Current Recommendations

AAP, 2010	• To prevent exacerbation of the athlete's symptoms and allow for continued recovery, "**cognitive rest**" is recommended.
AMSSM, 2012	• Students will require **cognitive rest** and may require academic accommodations such as reduced workload and extended time for tests while recovering from a concussion.
AAN, 2013	• LHCPs might develop individualized graded plans for return to physical and **cognitive activity,** guided by a carefully monitored, clinically based approach to minimize exacerbation of early postconcussive impairments (Level C).
NATA, 2014	• Athletic trainers should work with school administrators and teachers to include appropriate **academic accommodations** in the concussion-management plan. Strength of Recommendation: C

94

Cognitive Rest



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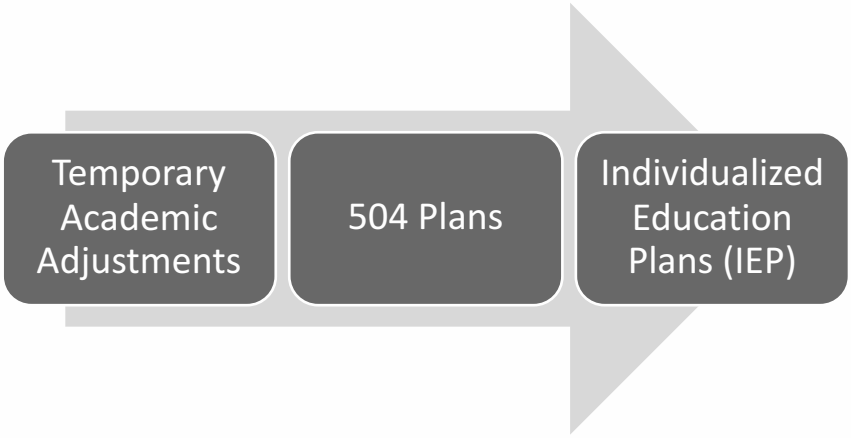
Policies



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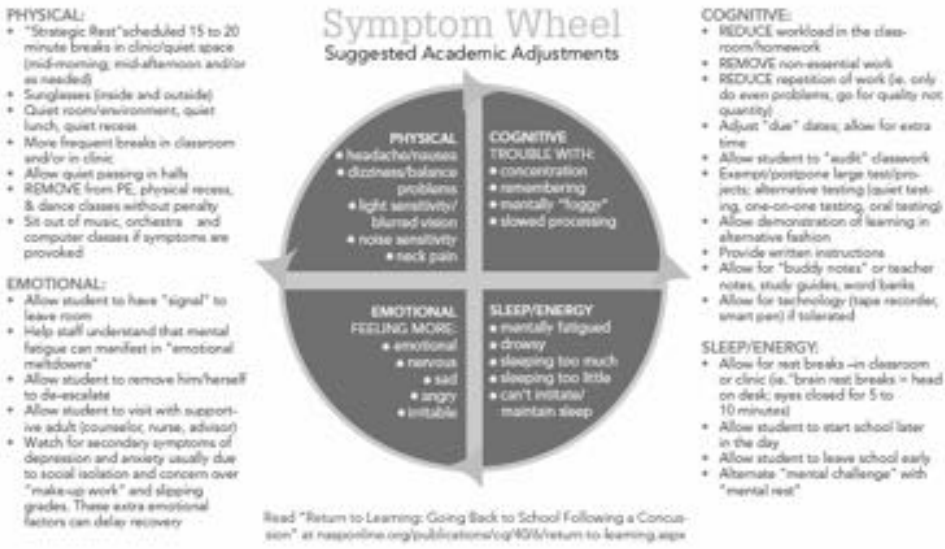
Accommodations

Type of Accommodation	Definition	Time frame	Implementation Mechanism
Academic adjustment	Non-formalized changes in environment	3-5 weeks	Informal negotiation with teachers and academic administrators
Academic Accommodation	Longer academic accommodation needs (i.e. alternative arrangements for standardized testing	5 weeks – 4 months	504 Plan
Academic Modification	More prolonged changes necessary (special education)	> 4- 6 months	Individualized Education Plan (IEP)

Parsons & Williams, Quick Questions in Concussion, 2015



http://issuu.com/healthone/docs/reap_oct21

98

Beliefs, Attitudes & Knowledge

BAKPAC

of Pediatric Athletes with Concussion

Healthcare Providers	School Personnel
Athletic Trainers	School Counselors
School Nurses	Principals
Physicians	Superintendents
Physician Assistants	Teachers
	Coaches

Concussion Management, Academic Adjustments

Knowledge, Management, Academic Adjustments

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Return to Activity

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Return to Play

- Consider the following:
  - Athlete's previous history of concussion
  - Type of sport (contact vs non-contact)
  - Availability of experienced personnel
    - Observe & monitor athlete during recovery
  - Age?

Guskiewicz, *J Athl Train.* 2004

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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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Return to Play Decision

- Return to baseline function on adjunct tests
- Restricted activity (sport specific) for the first few days following the injury
- If still asymptomatic can move to unrestricted
- After repeat injury withhold for an extended period of time (~3 days) after symptom resolution

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Graded RTP Progression

TABLE 1. Graduated Return to Play Protocol

Rehabilitation Stage	Functional Exercise at Each Stage of Rehabilitation	Objective of Each Stage
1. No activity	Complete physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity <70% MPHR; no resistance training	Increase HR
3. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer; no head impact activities	Add movement
4. Non-contact training drills	Progression to more complex training drills, eg, passing drills in football and ice hockey; may start progressive resistance training	Exercise, coordination, and cognitive load
5. Full contact practice	Following medical clearance, participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6. Return to play	Normal game play	

~24 hours between each stage

McCrory et al, 2009

104

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

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?
3. How compliant are healthcare providers in following current return-to-activity guidelines?
4. How effective are the graded return-to-activity protocols in improving patient outcomes following concussion?

Valovich McLeod, Lewis, Whelihan, Welch Bacon, *J Athl Train*. In press. 105

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.

New Spin on the RTP Progression

- **Step 2 – Light Aerobic Exercise**
  - Aerobic: ACSM
  - Exercises for balance – static
  - Exercises for VOR (eye-head coordination) – seated
  - Exercises for vision – head stable in sitting/standing
- **Step 3 – Sports Specific Exercises**
  - Aerobic: ACSM moderate -- running drills, sport-specific
  - Exercises for balance – dynamic and add dual tasking
  - Exercises for VOR – in standing>>walking>>jogging
  - Exercises for vision – more dynamic and add dual tasking
- **Step 4 – Non-contact drills**
  - More aggressive sport specific exercises, strengthening and/or plyometrics
  - Balance and VOR – typically not needed at this phase unless VOR at very high demands
  - Vision – high demand and sport-specific training…more athletic enhancement
- **Step 5 – Full contact after medical clearance – should have no symptoms**
  - Consider Buffalo treadmill test for a final exertional test
  - Serial testing: cognitive, visual/oculomotor, balance/vestibular
- **Step 6 – Game Day!**

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Slide Courtesy of Bridgett Wallace, PT, DPT

Continuing Rehab after return?

- Is sport specific activity enough?
- Monitor productivity on the field/court/sport
- Continuing with vestibular and ocular therapy?

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Re-assess after they have returned?

- Monitoring and documenting symptoms score after the patient has returned
- Other assessment needed?
- Sport performance assessment & documentation

"Yeah, he seems to be playing pretty well on the sprained ankle. But I want to be miles away when the athletic trainer peels that tape off his hairy leg."

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Concussion Management Team

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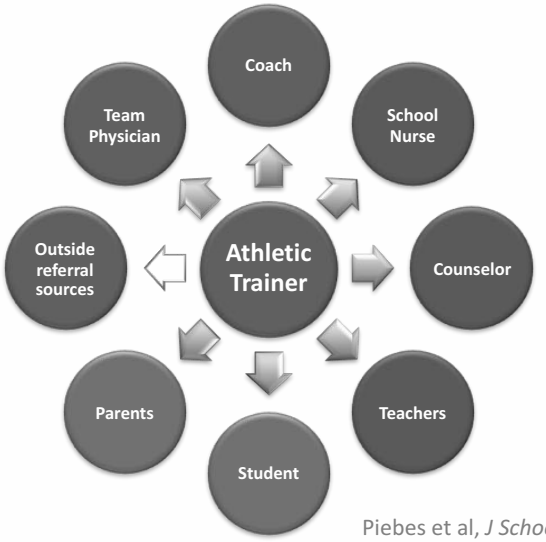
Team	Team Members	Roles
Family	Patient, parents, guardians, relatives, peers, teammates, family friends	Impose rest Monitor and track symptoms at home including emotional and sleep-related symptoms daily Communicate with school teams
Medical	Primary care provider, team physician, emergency department, 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

Communication: Secondary School



Piebes et al, *J School Nursing*, 2009

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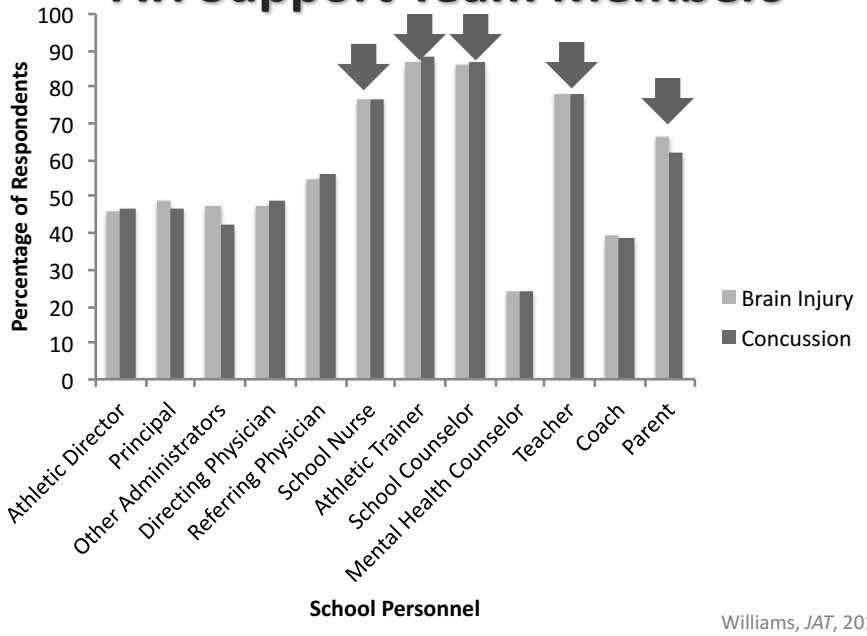
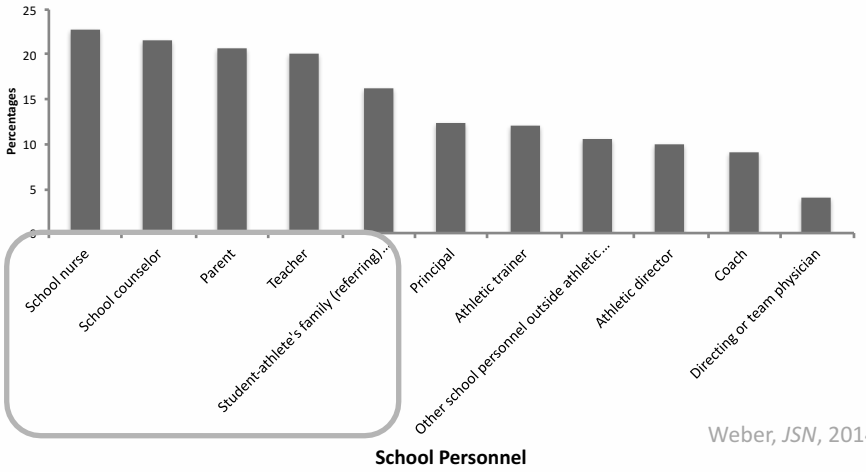
AT: Support Team Members



Williams, *JAT*, 2015

School Nurse: Support Team Members



Weber, *JSN*, 2014

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Treatment Team

- Meet with treatment team
- Decide on criteria for referral to each specialist
- Discuss and decide on interventions strategies that can be done by AT as part of treatment and early intervention

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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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Treatment 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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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

Barriers to Concussion Treatment

Access to Care

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Only 60% of ACMS physician members indicated they had multidisciplinary concussion clinic within 60 miles of their medical practice

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Rose, *Sports Health,* 2016

Telemedicine Example

Barrow Concussion Network

ATSU

A.T. STILL UNIVERSITY

BARROW CONCUSSION NETWORK

https://www.barrowneuro.org/get-to-know-barrow/centers-programs/concussion-brain-injury-center/barrow-concussion-network

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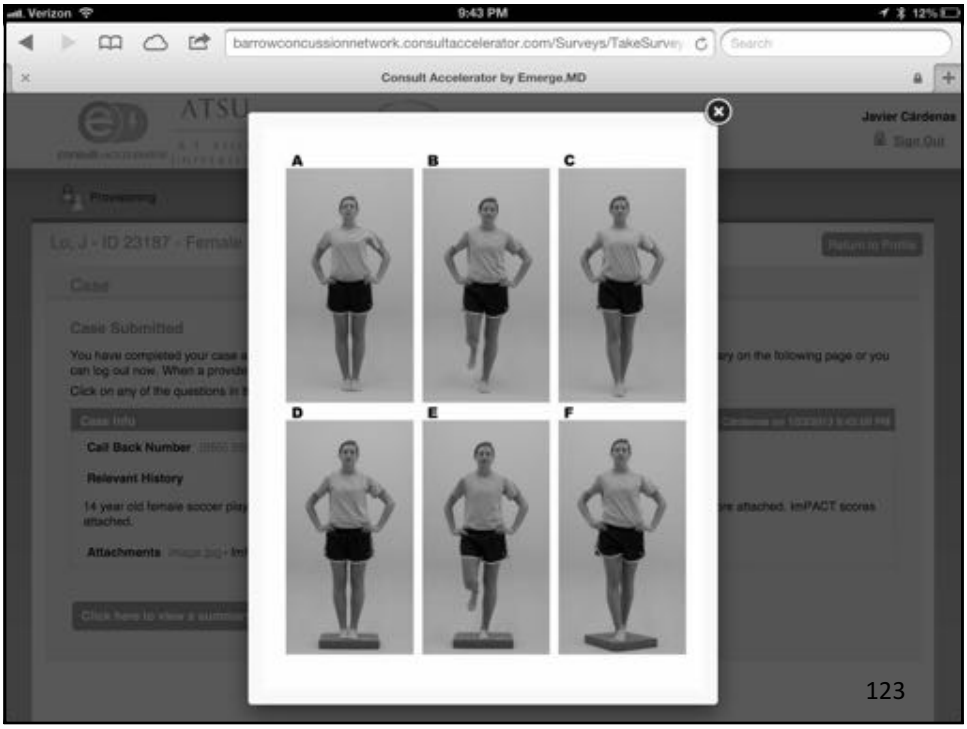

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Plan Implementation

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Who?	• Medical, School, Athletic, and Family
What?	• Written Concussion Policy • Communication
When?	• Preseason • In-season
Where?	• School or district level • Athletic trainer, directing physician level
How?	• In-services and educational sessions • Routine practice

Concussion Plan Components

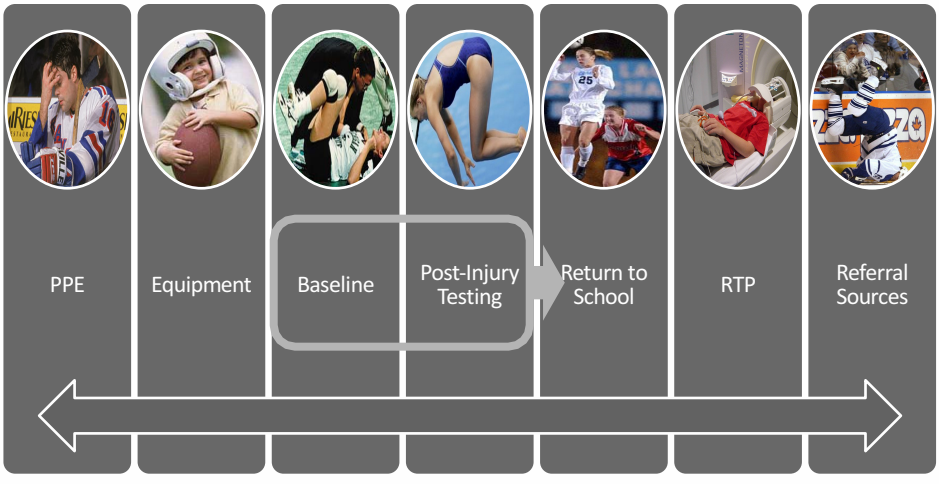

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Table 1
School concussion management: activities and responsibilities

Activity	Responsible Parties	Completion Date	Evidence of Completion
Before school year			
1. Concussion management policies & procedures	School administration (school nurse, counselor, psychologist)	Before start of school year	Written policy in school manual, copy provided to all school staff
2. Development of school concussion resource team	School administration, including school nurse, counselor, psychologist, designated teacher, athletic trainer	Before start of school year	Written policy in school manual
3. Examine teaching/support methods to support recovery, maximize learning/performance, and reduce symptom exacerbation	School administration, including school nurse, counselor, psychologist	Before start of school year	Written policies on teaching methods
4. Teacher/staff education & training (online video training, CDC school professional fact sheet)	Teacher, school counselor, school nurse, administrators	Before start of school year	Verification of completion provided to school administration
5. Develop list of concussion resources for education, consultation & referral (medical, school, state/local Brain Injury Association)	School administration	Before start of school year	List of resources provided in policies & procedures, available to school staff & families
During school year (preinjury)			
1. Review/reinforce concussion policy and procedures	School administration, school nurse/ counselor	First faculty meeting, parent back to school night	Verbal report
2. Monitoring for injury, parent informed of injury	Coach, athletic trainer, school health personnel	Day of injury	Concussion symptom checklist, parent provided ACE Postconcussion Home/ School Instructions
School management (postinjury)			
1. Medical evaluation & school treatment planning	Licensed health care professional with concussion training, school concussion resource team	Early postinjury	Plan for school return/activity
2. Gradual return to school program	Licensed health care professional with concussion training, school concussion resource team	When medically determined to tolerate >30 minutes of cognitive activity	Medical documentation
3. In-school observation, monitoring, & supports	School concussion resource team	Ongoing	Concussion symptom checklist
4. Clearance for full return to academics	Licensed health care professional with concussion training, school concussion resource team	Asymptomatic with full cognitive exertion	Medical documentation (provided to family and school)

Abbreviations: ACE, Acute Concussion Evaluation; CDC, Centers for Disease Control and Prevention.

Sady, *PMR Clin*, 2011

Implementing Accommodations

- Point notifies school staff, parents, and directing physician
  - Indicate concussed athlete
  - Provide relevant details
  - Remind student may need temporary assistance
- If non-school concussion, individual who first learns of it begins communication

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Implementing Accommodations

- Shared recovery information
  - Symptom resolution/exacerbation
  - Adjunct assessment scores
  - Clinical presentation
- Consistent message to student from all adults
  - Honesty with symptoms
  - Full recovery in academics before RTP
- Use clinical data to guide adjustments

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www.concussionvitalsigns.com

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Acute Concussion Evaluation (ACE)

www.cdc.gov/concussion

A. Injury Characteristics Date/Time of Injury________________ Reporter: __Patient __Parent __Spouse __Other______

1. Injury Description ______________________________

1a. Is there evidence of a forcible blow to the head (direct or indirect)? __Yes __No __Unknown
1b. Is there evidence of intracranial injury or skull fracture? __Yes __No __Unknown
1c. Location of Impact: __Frontal __Lft Temporal __Rt Temporal __Lft Parietal __Rt Parietal __Occipital __Neck __Indirect Force
2. Cause: __MVC __Pedestrian-MVC __Fall __Assault __Sports (specify)________ Other________
3. Amnesia Before (Retrograde) Are there any events just BEFORE the injury that you/ person has no memory of (even brief)? __ Yes __No Duration
4. Amnesia After (Anterograde) Are there any events just AFTER the injury that you/ person has no memory of (even brief)? __ Yes __No Duration
5. Loss of Consciousness: Did you/ person lose consciousness? __ Yes __No Duration
6. EARLY SIGNS: __Appears dazed or stunned __Is confused about events __Answers questions slowly __Repeats Questions __Forgetful (recent info)
7. Seizures: Were seizures observed? No__ Yes__ Detail________

B. Symptom Check List* Since the injury, has the person experienced any of these symptoms any more than usual today or in the past day?
Indicate presence of each symptom (0=No, 1=Yes). *Lovell & Collins, 1998 JHTR

PHYSICAL (10)		COGNITIVE (4)		SLEEP (4)	
Headache	0 1	Feeling mentally foggy	0 1	Drowsiness	0 1
Nausea	0 1	Feeling slowed down	0 1	Sleeping less than usual	0 1 N/A
Vomiting	0 1	Difficulty concentrating	0 1	Sleeping more than usual	0 1 N/A
Balance problems	0 1	Difficulty remembering	0 1	Trouble falling asleep	0 1 N/A
Dizziness	0 1	COGNITIVE Total (0-4) ____		SLEEP Total (0-4) ____	
Visual problems	0 1	EMOTIONAL (4)			
Fatigue	0 1	Irritability	0 1		
Sensitivity to light	0 1	Sadness	0 1		
Sensitivity to noise	0 1	More emotional	0 1		
Numbness/Tingling	0 1	Nervousness	0 1		
PHYSICAL Total (0-10) ____		EMOTIONAL Total (0-4) ____			
(Add Physical, Cognitive, Emotion, Sleep totals) Total Symptom Score (0-22)			____		

Exertion: Do these symptoms worsen with:
Physical Activity __Yes __No __N/A
Cognitive Activity __Yes __No __N/A

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

C. Risk Factors for Protracted Recovery *(check all that apply)*

Concussion History? Y ___ N___	√	Headache History? Y ___ N___	√	Developmental History	√	Psychiatric History
Previous # 1 2 3 4 5 6+		Prior treatment for headache		Learning disabilities		Anxiety
Longest symptom duration Days__ Weeks__ Months__ Years__		History of migraine headache __Personal __Family________		Attention-Deficit/ Hyperactivity Disorder		Depression
						Sleep disorder
If multiple concussions, less force caused reinjury? Yes__ No__				Other developmental disorder________		Other psychiatric disorder________

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

D. RED FLAGS for acute emergency management: Refer to the emergency department with sudden onset of any of the following:
* Headaches that worsen
* Seizures
* Focal neurologic signs
* Looks very drowsy/ can't be awakened
* Repeated vomiting
* Slurred speech
* Can't recognize people or places
* Increasing confusion or irritability
* Weakness or numbness in arms/legs
* Neck pain
* Unusual behavioral change
* Change in state of consciousness

E. Diagnosis (ICD): __Concussion w/o LOC 850.0 __Concussion w/ LOC 850.1 __Concussion (Unspecified) 850.9 __Other (854)________ __No diagnosis

F. Follow-Up Action Plan Complete *ACE Care Plan* and provide copy to patient/family.
___ No Follow-Up Needed
___ Physician/Clinician Office Monitoring: Date of next follow-up________
___ Referral:
___ Neuropsychological Testing
___ Physician: Neurosurgery___ Neurology___ Sports Medicine___ Physiatrist___ Psychiatrist___ Other________
___ Emergency Department

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Returning to School (Continued)

Until you (or your child) have fully recovered, the following supports are recommended: *(check all that apply)*

__No return to school. Return on (date)________
__Return to school with following supports. Review on (date)________
__Shortened day. Recommend ___ hours per day until (date)________
__Shortened classes (i.e., rest breaks during classes). Maximum class length: _____ minutes.
__Allow extra time to complete coursework/assignments and tests.
__Lessen homework load by ______%. Maximum length of nightly homework: _____ minutes.
__No significant classroom or standardized testing at this time.
__Check for the return of symptoms (use symptom table on front page of this form) when doing activities that require a lot of attention or concentration.
__Take rest breaks during the day as needed.
__Request meeting of 504 or School Management Team to discuss this plan and needed supports.

Returning to Sports

1. **You should NEVER return to play if you still have ANY symptoms** – (Be sure that you do not have any symptoms at rest and while doing any physical activity and/or activities that require a lot of thinking or concentration.)
2. Be sure that the PE teacher, coach, and/or athletic trainer are aware of your injury and symptoms.
3. It is normal to feel frustrated, sad and even angry because you cannot return to sports right away. With any injury, a full recovery will reduce the chances of getting hurt again. It is better to miss one or two games than the whole season.

The following are recommended at the present time:

___ Do not return to PE class at this time
___ Return to PE class
___ Do not return to sports practices/games at this time
___ Gradual return to sports practices under the supervision of an appropriate health care provider (e.g., athletic trainer, coach, or physical education teacher).

- Return to play should occur in gradual steps beginning with aerobic exercise only to increase your heart rate (e.g., stationary cycle); moving to increasing your heart rate with movement (e.g., running); then adding controlled contact if appropriate; and finally return to sports competition.
- Pay careful attention to your symptoms and your thinking and concentration skills at each stage of activity. Move to the next level of activity only if you do not experience any symptoms at the each level. If your symptoms return, let your health care provider know, return to the first level, and restart the program gradually.

Gradual Return to Play Plan

1. No physical activity
2. Low levels of physical activity (i.e., *symptoms do not come back during or after the activity*). This includes walking, light jogging, light stationary biking, light weightlifting (lower weight, higher reps, no bench, no squat).
3. Moderate levels of physical activity with body/head movement. This includes moderate jogging, brief running, moderate-intensity stationary biking, moderate-intensity weightlifting (reduced time and/or reduced weight from your typical routine).
4. Heavy non-contact physical activity. This includes sprinting/running, high-intensity stationary biking, regular weightlifting routine, non-contact sport-specific drills (in 3 planes of movement).
5. Full contact in controlled practice.
6. Full contact in game play.

*Neuropsychological testing can provide valuable information to assist physicians with treatment planning, such as return to play decisions.

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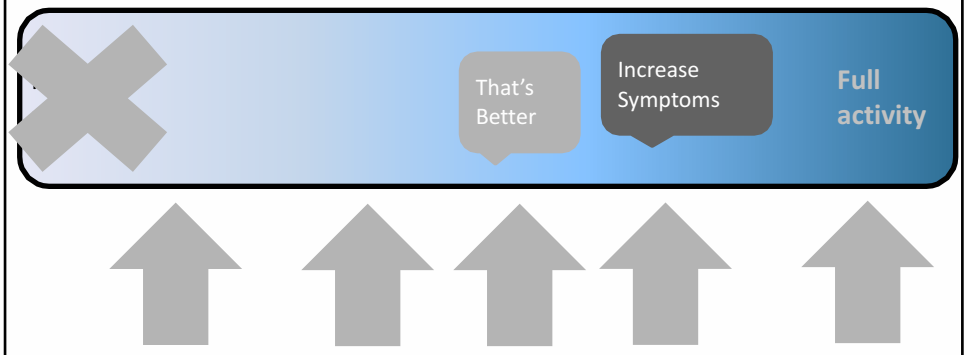
Stage	Description	Activity Level	Criteria to Move to Next Stage
0	No return, at home	Day 1 - Maintain low level cognitive and physical activity. No prolonged concentration. Cognitive Readiness Challenge: As symptoms improve, try reading or math challenge task for 10-30 minutes; assess for symptom increase.	To Move To Stage 1: (1) Student can sustain concentration for 30 minutes before significant symptom exacerbation, AND (2) Symptoms reduce or disappear with cognitive rest breaks* allowing return to activity.
1	Return to School, Partial Day (1-3 hours)	Attend 1-3 classes, with interspersed rest breaks. Minimal expectations for productivity. No tests or homework.	To Move To Stage 2: Student symptom status improving, able to tolerate 4-5 hours of activity with 2-3 cognitive rest breaks built into school day.
2	Full Day, Maximal Supports (maximal supports required throughout day)	Attend most classes, with 2-3 rest breaks (20-30'), no tests. Minimal HW (≤ 60'). Minimal-moderate expectations for productivity.	To Move To Stage 3: Number & severity of symptoms improving, needs only 1-2 cognitive rest breaks built into school day.
3	Return to Full Day, Moderate Supports (moderate supports provided in response to symptoms during day)	Attend all classes with 1-2 rest breaks (20-30'); begin quizzes. Moderate HW (60-90') Moderate expectations for productivity. Design schedule for make-up work.	To Move To Stage 4: Continued symptom improvement, needs no more than 1 cognitive rest break per day
4	Return to Full Day, Minimal Supports (Monitoring final recovery)	Attend all classes with 0-1 rest breaks (20-30'); begin modified tests (breaks, extra time). HW (90+') Moderate-maximum expectations for productivity.	To Move To Stage 5: No active symptoms, no exertional effects across the full school day.
5	Full Return, No Supports Needed	Full class schedule, no rest breaks. Max. expectations for productivity. Begin to address make-up work.	N/A

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

- Physical and cognitive rest is underutilized by healthcare providers (Strength of Recommendation = B)
- Moderate physical and cognitive rest may facilitate recovery during the initial days after concussion (Strength of Recommendation = B)
- Significant variability in the use of assessment tools and compliance with recommended return-to-activity guidelines exists (Strength of Recommendation = B)
- There is little evidence to support the effectiveness of the graded return-to-activity progression (Strength of Recommendation = D)

Valovich McLeod, Lewis, Whelihan, Welch Bacon, *J Athl Train.* In press. 134

Symptom Limited Cognitive Rest



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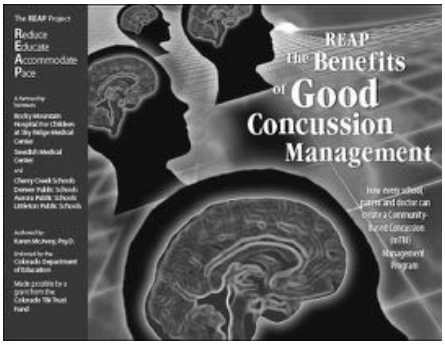

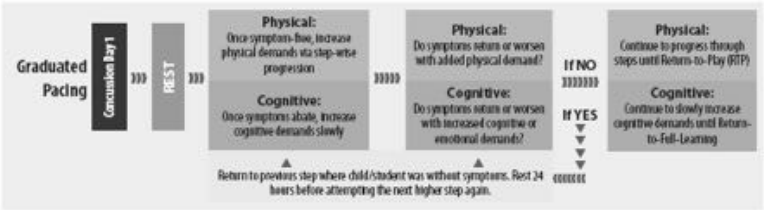

http://www.biacolorado.org/resources/reap.pdf

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REAP suggests the following timeframe:

	TEAM	WEEK 1	WEEK 2	WEEK 3
FT	**Family Team** Help child understand he/she must be a "honest partner" in the rating of symptoms	• Impose REST • Assess symptoms daily – especially monitor maintenance symptoms and emotional symptoms.	• Continue to assess symptoms (at least 2X week or more as needed), monitor if symptoms are improving. • Increase demands and assess symptoms.	• Continue with all assessments (at least 2X week or more as needed) • Increase or decrease demands based upon outcome (see PACE).
ST/P	**School Team – Physical Coach/ATC/School Nurse** (2 point person to oversee/ manage physical symptoms)	• REAP suggests immediate removal from play/ physical activities! • Assess physical symptoms daily, use objective rating scale. • ATC/Coach: assess postural-stability (see NATA reference in RESOURCES). • School Nurse: monitor visits to school clinic. If symptoms at school are significant, contact parents and send home from school.	• Continue to assess that symptoms are improving (at least 2X week or more as needed). • Step-wise increase in physical demands (see PACE). • ATC/Coach: postural-stability assessment.	• Continue with all assessments (at least 2X week or more as needed). • Increase or decrease demands based upon outcome (see PACE.) • ATC/Coach: do postural-stability re-assessment.
ST/C	**School Team – Cognitive Educators, School Psychologist, Counselor, Social Worker** (2 point person to oversee/ manage cognitive/emotional symptoms) *Get a Release of Information signed immediately to talk to MD	• Reduce all cognitive demands immediately! (Reduce, do not eliminate cognitive demands) • Meet with student individually to create academic accommodation plan for cognitive/ emotional reduction no later than Day 2/3 & then assess again. • Educate all teachers on the symptoms of concussion (see "Concussion is More Than a Bump to the Head" in Appendix). • Make immediate academic accommodations (see ACCOMMODATIONS).	• Continue to assess that symptoms are improving (at least 2X week or more as needed). • Slow increase in cognitive demands (see PACE). • Continue academic accommodations as needed.	• Continue with all assessments (at least 2X week or more as needed). • Increase or decrease demands based upon outcome (see PACE). • Continue academic accommodations as needed. • Assess if longer term academic accommodations may need to be made (504 Plan, IEP, etc.).
MT	**Medical Team**	• Assess and diagnose concussion. • Monitor that symptoms are improving throughout Week 1 - not worsening in the first 48 to 72 hours.	• Continue to consult with school and home teams. • Follow-up medical check including: comprehensive history, neurologic exam, detailed assessment of mental status, cognitive function, gait and balance.	• Continue to consult with school and home teams.

McAvoy, 2009

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Table 6 Pediatric-Specific Concussion Recommendations

Organization	Recommendation
American Academy of Neurology (Giza et al., 2013)	Athletes of high school age or younger with diagnosed concussion should be managed more conservatively regarding return to activity.
	Concussion assessment tools for the evaluation of athletes of preteen age or younger should be age appropriate and demonstrate appropriate psychometric properties of reliability and validity.
American Medical Society for Sports Medicine (Harmon et al., 2013)	Younger athletes may have a more prolonged recovery and are more susceptible to a concussion accompanied by a catastrophic injury.
	Students will require cognitive rest and may require academic accommodations such as reduced workload and extended time for tests while recovering from a concussion.
National Athletic Trainers' Association (Broglio et al., 2014)	Athletic trainers should be aware that children and adolescents may take longer to recover and require a prolonged return-to-activity progression.
	Age-appropriate, validated concussion assessment tools should be used in younger populations.
	The assessment of symptoms in pediatric patients should include age-validated, standardized symptom scales and the formal input of a parent, teacher, or responsible adult.
	Pediatric athletes may require more frequent updates to baseline assessments to account for continued brain development.
	Medical personnel should work with school personnel to include appropriate academic accommodations in the concussion management plan.
International Concussion in Sport Group (McCrory et al., 2013)	The clinical evaluation of children and adolescents should include both patient and parent input and appropriate symptom checklists.
	Teacher and school input may be appropriate in determining management strategies.
	Cognitive tests must be age appropriate and the timing of administration may differ to assist with school and home management.
	Pediatric neuropsychologists are the preferred clinicians to interpret pediatric cognitive assessments, especially in children with learning disabilities or attention deficit hyperactivity disorder.
	Children and adolescents should not return to activity on the same day as the injury.
	Return to sport or activity should only be considered once the child or adolescent has returned to school successfully.
	Children should engage in cognitive rest and limit exertion with activities of daily living that may increase symptoms.
	Children should not return to activity until symptoms have resolved and they may require a more conservative approach to return to activity.

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Take Home Points

- Concussions are a concern in youth and high school athletes
- Assessment tools need to be age appropriate
- Management should take a whole-person approach
- Return to school and activity is best achieved with a collaborate approach

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AT PBRN

Athletic Training Practice-Based Research Network

www.atpbrn.org

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