

Update on Concussion Management for the Rhode Island Clinician

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ABSTRACT

Concussions are common injuries with increasing diagnostic incidence. The 4th International Conference on Concussion in Sport, held in November 2012 in Zurich, revised consensus statements regarding the definition of a concussion, diagnostic criteria, and management. Return-to-play guidelines require a graded return to activity in which concussed athletes remain symptom-free. In order to improve awareness pertaining to concussion diagnosis and management, legislation has now been enacted in all fifty states. Rhode Island enacted into law the School and Youth Programs Concussion Act in 2010, which increases awareness of concussions for athletes, coaches, teachers, school nurses and parents/guardians through written information and mandatory training for coaches. Athletes must be removed from practice/competition and cannot return until a physician has evaluated and cleared them.

KEYWORDS: concussion, traumatic brain injury, trauma, sports medicine

INTRODUCTION

Since 1999, there has been increased research on concussion¹, and more coaches and health care professionals are aware of management.² Prior concussion management protocols allowed some athletes to return to play within 15 minutes of injury.¹ The 4th International Conference on Concussion in Sport was held in November 2012 in Zurich.³ Its purpose included updating information involving the complex pathophysiology, diagnosis, and treatment of concussions.

EPIDEMIOLOGY

There are approximately 3.8 million sports and recreation-related concussions in the United States annually.⁴ Roughly 50% of concussions go unreported.⁴ From 2001 to 2005 in the United States, there were nearly 502,000 emergency room visits in children ages 8 to 19 for concussion diagnosis and management.⁵

The number of high school athletes diagnosed with sports-related concussion is rising.⁶ American football has the highest number of concussions for males in high school (HS), while soccer has the highest number for HS females.²

However, high-risk sports such as ice hockey and rugby have lower participation rates among HS athletes nationally, and thus are omitted from epidemiologic reports.

DEFINING CONCUSSION

Concussion is a brain injury in which biomechanical forces lead to a complex pathophysiological process resulting in immediate and transient alteration in brain function.^{3,7} Kinetic energy to the cranium leads to both acceleration-deceleration and rotational mechanisms.⁸

Animal models have suggested that the pathophysiology of a concussion involves disruption of the neuronal membrane resulting in a potassium efflux into the extracellular space, which prompts release of the excitatory amino acid glutamate and metabolic dysfunction.^{1,8} The concussed brain is less responsive to neural activation, and if the patient does any premature physical or cognitive activity before the brain has completely recovered, there is an increased risk of prolonged and worsened brain dysfunction.⁴

Second Impact Syndrome (SIS), a rare complication of concussion not universally accepted among experts, is believed to be a catastrophic consequence of repeated head injury in sport that can lead to death.⁹ It is generally thought to have 100% morbidity and 50% mortality. A lack of evidence for this condition exists in the literature. There are only anecdotal case reports currently, with all subjects being under age 25.⁹ With SIS, an athlete sustains an initial head injury, and then sustains a second injury prior to full resolution of symptoms from the initial head injury that can lead to catastrophic brain swelling and usually death.⁹

CLINICAL EXAMINATION

Common symptoms of concussion reported by patients are in **Table 1**.^{3,10,11} Clinicians should look for signs of concussion as patients may not recognize that they suffered a concussion. Signs of concussion include poor balance or motor coordination, slow/slurred speech, poor concentration, delayed responses to questions, "blank stare," poor sport performance, unusual emotions, personality change and inappropriate behaviors.^{3,10,11} Younger athletes take longer to recover from concussions¹, and athletes who have previously had a concussion should be expected to have symptoms longer.¹²

Factors including poorer performance on neurocognitive

Table 1. Signs/Symptoms of Concussion

Headache	Dazed Feeling	Light sensitivity (photophobia)	Ringing in the ears (tinnitus)
Dizziness/vertigo	Fatigue	Irritability	Confusion
Disorientation	Seizure/convulsion	Nausea/Vomiting	Sound sensitivity (phonophobia)
Poor balance or coordination	Delayed responses to questions	Slow or slurred speech	Poor concentration or ability to focus
Vacant stare	Unusual emotions	Personality change	Inappropriate behavior
“Don’t feel right”	Amnesia	Loss of consciousness	Neck pain
Insomnia	Visual problems	Excessive sleepiness	

Patients with concussion can have a variety of symptoms; some of the common symptoms are listed in the table above.^{3,11,13}

Table 2. Commonly Used Concussion Tests and Scales^{2-4,11,15}

	Examples	Description	Key Features	Use	Availability
Sideline Assessments	1. Sports Concussion Assessment Tool (SCAT3™) 2. Standardized Assessment of Concussion (SAC)	Standardized tests to evaluate for concussion	Symptom inventory, physical examination, gross cognitive assessments, balance assessments	Sideline or office	Most are free, available on internet
Computerized Neurocognitive Assessments	1. ANAM® 2. CogState Sport® 3. Headminder® 4. ImPACT®	Computerized tests for cognitive function	20-40 min computerized evaluation of reaction time, concentration processing speed, symptoms, and memory	Office based	Practitioner must purchase
Balance Assessments	1. Balance Error Scoring System (BESS)	Timed balance assessment in different stances	Athletes performs double, single and tandem leg stances and errors are recorded	Office based	SCAT3™ contains a modified version
Symptom Inventories	1. Postconcussion Symptom Scale (PCSS) 2. Graded Symptom Checklist (GCS)	Common concussion symptoms are rated	Form of a questionnaire	Sidelines or office based	Free and available on the internet

reaction time and visual memory composites are associated with a protracted recovery. Subacute symptoms – including migraines, other headaches, and dizziness that linger 2 to 3 days after injury – have also been potential predictors of protracted recovery.¹³ A balance assessment can include a Romberg test, tandem walking, heel to toe, and Balance Error Scoring System (BESS).

A variety of testing can be done either in the office or on the sidelines for concussion diagnosis and management (Table 2). The Sport Concussion Assessment Tool (SCAT3) assists with completing a clinical profile of the concussed patient incorporating the Glasgow Coma Scale (GCS).^{3,14} The GCS should be followed after a concussion. Children under 12 years old should be assessed with the Child SCAT3.¹⁴

Neurocognitive testing is often performed during the pre-season so that in the event of a concussion, a comparison can be made to help with concussion management.⁴ Assessment of a concussion should always remain the combination of clinical examination, completion of a self-reported symptom checklist, postural assessment, and neurocognitive testing.¹⁵

DIAGNOSTIC IMAGING

Imaging including CT scan or MRI offer little to the evaluation of a concussion unless there is concern for a cervical

spine injury, skull fracture, epidural hematoma, subdural hematoma, diffuse axonal injury, intracerebral hemorrhage, or subarachnoid hemorrhage.^{1,3}

NEUROPSYCHOLOGICAL ASSESSMENT

Clinicians and scientists have been designing and studying different objective tools to help determine when a patient has recovered from a concussion. Common neuropsychological testing assessment tools are the Automated Neuropsychological Assessment Metrics (ANAM)®, CogState Sport®, HeadMinder®, ImPACT®, and pen and paper testing by a neuropsychologist.^{1,11}

Often neurocognitive testing is not done properly.¹⁵ It is recommended that neurocognitive testing be interpreted by healthcare professionals who are trained and familiar with the type of test being performed.⁴ There are individual test limitations including false positive and false negative rates, baseline variability, practice effect, poor test-retest reliability, and improper assessment of the reliable change index by practitioners.⁴ For this reason, it should be used as an adjunct only to help with return to play. It cannot be emphasized enough that a patient being asymptomatic prior to return to contact or collision sports is the most important aspect of concussion management.¹¹

LABORATORY ASSESSMENT

Currently, there is no utility to laboratory evaluation of patients with concussions. The significance of Apolipoprotein (Apo) E4, ApoE promoter gene, Tau polymerase, and other genetic markers are unclear in how they can be used to diagnose or treat concussions.³ Biochemical serum and cerebral spinal fluid biomarkers of brain injury including S-100, neuron specific enolase (NSE), myelin basic protein (MBP), GFAP, tau, etc. are not clinically indicated at this time. Swedish hockey players had increased levels of the axonal injury marker total tau compared to preseason values and that the levels of S-100 calcium binding protein B were also increased in post-concussive patients compared to preseason values.¹⁶ The total tau and S-100 calcium binding protein B were highest immediately after the concussion and decreased during rehabilitation.¹⁶

MODULATION OF SYMPTOMS

There is no evidence that non-steroidal anti-inflammatories or acetaminophen shorten the duration of symptoms of a concussion.¹ Due to risk of bleeding, aspirin and NSAIDs should be avoided in the acute concussive setting.⁴ Athletes

who take analgesics for 1-2 weeks in the acute concussion setting are also at risk for rebound headaches. Environmental modifications can include utilizing a quiet and dim setting to help with symptoms of light and noise sensitivity.⁴

There are circumstances where pharmacology therapy is indicated for concussion modulation. Specific or prolonged symptoms including sleep disturbances, anxiety, depression, post-concussive headache, and cognitive impairment may warrant prescription medication.³ Pharmacologic therapy should be prescribed only by clinicians experienced with concussion management.³ In order to be safely back to sport, patients should not be taking any specific medications that could potentially modify the symptoms/signs of a concussion.³

RETURN-TO-PLAY CRITERIA (Table 3)

A graduated return-to-play criteria consists of taking a patient through a stepwise progression with each step lasting at least 24 hours, with no advancement if the patient remains symptomatic.^{1,3,11} If at any time an athlete develops symptoms, they must reduce activity to a lower stage and remain asymptomatic for at least 24 hours prior to progressing.¹¹ **Table 3** outlines the return to play criteria for an athlete and **Table 4** outlines a modified return to play criteria for the recreational athlete.¹¹ The optimal rest period before re-initiation of aerobic activity and physical exertion has yet to be determined.³

RETURN-TO-SCHOOL CRITERIA

The 2004 and 2008 international conferences on concussion initiated the concept of cognitive rest after concussion in addition to physical rest.¹ Some patients have increased symptoms after a concussion with cognitive activities including attending school, focusing on schoolwork, taking exams, reading and attempting to stay up to date on assignments.¹ Halstead also suggests that because most children appear physically normal post-concussion, some

Table 3. Return to Play

Stage	Activity Allowed	Examples
1	No activity	Physical and cognitive rest
2	Light aerobic	Walking, swimming, stationary cycling (70% Maximum Heart Rate)
3	Sport-Specific	Sport drills but no head impact or physical contact
4	Noncontact training drills	Complex drills, light resistance training
5	Full-contact practice	Normal training (after cleared by physician)
6	Return to play	Normal activities

General accepted guidelines/criteria for a step-wise progression to return to play.^{1,3,4,11}

Table 4. Modified Return to Play for the Recreational Athlete¹¹

Stage	Activity Allowed	Examples
0	No activity	Physical and Cognitive rest
1	Light Aerobic (70% Maximal Heart Rate) with minimal cognitive effort	Swimming, walking, elliptical, cycling
2	Moderate Aerobic (75 to 80% Maximal Heart Rate) with increased amount of cognitive effort, sport-specific drills	Swimming, walking, elliptical, cycling, sport-specific drills
3	Light resistance training, more complex drills	Resistance machine circuit, a few minutes of yoga (avoid certain poses) or spinning class
4	Return to general fitness classes, but less duration of time. Encourage breaks. Personal trainer sessions could resume at a lighter intensity with breaks.	Zumba®, aerobics, boot camps, and other intense classes
5	More intense resistance training, start with only part of a class and work towards a full class	CrossFit®, kettlebell training, and other classes that include Olympic lifts and plyometrics
6	Full participation in pre-concussion activities, participation in a full class	CrossFit®, kettlebell training, and other classes that include Olympic lifts and plyometrics

school officials and educators may not recognize the need for both environmental and academic adjustments.¹⁷ It is recommended that cognitive rest include temporary leave from school, shortening the patient's school day, reducing workload and increasing the amount of time to complete assignments.^{1,4}

EDUCATION OF PARENTS AND COACHES

Appropriate concussion recognition in youth sports relies on education of youth coaches, athletes, officials, school administrators, healthcare providers, and parents.⁴ Physicians need to discuss potential long-term consequences of a concussion and recurrent concussions with athletes and parents including the potential risk for chronic traumatic encephalopathy.⁴ A cross-sectional survey of pediatrician members of the Illinois pediatricians revealed only 27% of participants were familiar with the Illinois state concussion legislation and only 15% knew the latest Zurich guidelines.¹⁸

The Center for Disease Control (CDC)'s "Heads Up: Concussion in Youth Sports" initiative was launched in 2007.¹⁹ Seventy-seven percent of coaches reported that they felt more comfortable identifying patients who may have a concussion and 63% viewed concussions as being a more serious medical issue.¹⁹

A 2007 study in by Guilmette et al²⁰ evaluated 109 New England HS football coaches' knowledge of concussion showing that most coaches could recognize symptoms and would consult a healthcare professional prior to allowing for return to play. The CDC's Heads Up initiative was seen by only 31% of coaches and was a less frequently used source of information.²⁰ The National Federation of State High School Associations (NFHS) also has concussion modules on their website that coaches can use to gain further knowledge.²¹

Educating coaches, parents, and athletes will not necessarily improve concussion management as 40% of surveyed athletes reported that they did not tell their coach about their concussion despite being aware of needing to report symptoms.²²

PREVENTION

The 2012 Zurich Conference consensus stated there was no good evidence that currently available protective equipment on the market is capable of preventing a concussion.³ Mouthguards, helmets, and headgear currently do not prevent concussion.³ Newer innovations in helmet design are currently being investigated, but study limitations such as lack of randomization of helmets among study participants continue to limit the application of such studies to player safety.²³

Collins et al advocated for the use of overall neck strength as a screening tool to determine which high school athletes have an increased concussion risk and which athletes should undergo neck-strengthening prevention programs.²⁴

For every one pound increase in neck strength, the odds of sustaining a concussion were decreased by 5%.²⁴

Some have advocated for rule changes in higher impact sports such as no tackling in football under age 16.²⁵ Video studies of men's and women's lacrosse concussions have been performed in HS athletes to evaluate the conditions in the game in which athletes suffer concussions. Men's lacrosse players typically were vulnerable when hit and there was head-to-head contact,²⁶ while women's lacrosse players wear little mandatory equipment and are at risk for accidental stick or body to the head contact.²⁷ Overall, the competitive and aggressive nature of sport should be balanced with fair play and respect for others.

RHODE ISLAND LAW

Between 2009–2014, all fifty states and the District of Columbia have passed legislation about sports concussion.^{18,28} The majority of the laws mandate that all concussed athletes be removed from activity immediately. Many states require that an athlete receive a physician clearance prior to returning to athletic activities. Rhode Island state law requires all school coaches, whether paid or volunteer, to take concussion awareness training.²⁹ The training is free and accessible online. The average amount of time to complete the training is approximately 30 minutes.³⁰

The Rhode Island School And Youth Programs Concussion Act was introduced by Senators Felag, Levesque, Bates, and Sosnowski on January 13, 2010. A concussion and head injury information sheet must be signed by the youth athlete and athlete's parent and/or guardian prior to participation. School districts are required to use training materials made available by the CDC entitled "Heads Up: Concussion in High School Sports/Concussion in Youth Sports." All coaches, trainers, and volunteers must complete the training course.³⁰

School districts have been encouraged to have all student athletes undergo baseline neurocognitive testing prior to the start of every sport season. Parents and guardians are provided with information as to the risk of concussion and traumatic brain injury prior to the start of every sport season and need to sign an acknowledgement that they received the information.²⁹

Youth athletes suspected of having sustained a concussion or head injury must be removed from practice or competition. A physician must evaluate the athlete and provide written clearance to allow any return to play. All school districts are encouraged to have an athletic trainer at all recreational and athletic events.²⁹ Recent communication with the Rhode Island Interscholastic League stated that as of September 2014, 15 of 57 Rhode Island high schools had athletic trainers on staff.

The latest amendment from 2014 (2014 R.I. Pub. Laws, Chap. 237 (2014 HB 7367)) directs the Department of Education to make guidelines for teachers and teachers' aides

to complete training for traumatic brain injuries and concussions. Under the latest amendment, school nurses are also required to complete a training course and perform an annual refresher course.²⁸

In summary, clinicians should familiarize themselves with the Zurich guidelines and the Rhode Island legislation if seeing concussed individuals in practice to ensure safe patient care.

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