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# Sport-related concussion: How best to help young athletes

Increased focus on sports concussion means you're likely to see greater numbers of children and adolescents with mild brain trauma. Here's what to keep in mind.

## PRACTICE RECOMMENDATIONS

- › *Require athletes who sustain a concussion to wait a minimum of 7 to 10 days before returning to full unrestricted activity.* (C)
- › *Ensure that any player diagnosed with concussion follows a guided return-to-play progression, supervised by an athletic trainer or physical therapist experienced in post-concussion care.* (C)
- › *Advise patients who are old enough to drive not to do so for at least 24 hours after a concussion.* (B)

### Strength of recommendation (SOR)

- (A) Good-quality patient-oriented evidence
- (B) Inconsistent or limited-quality patient-oriented evidence
- (C) Consensus, usual practice, opinion, disease-oriented evidence, case series

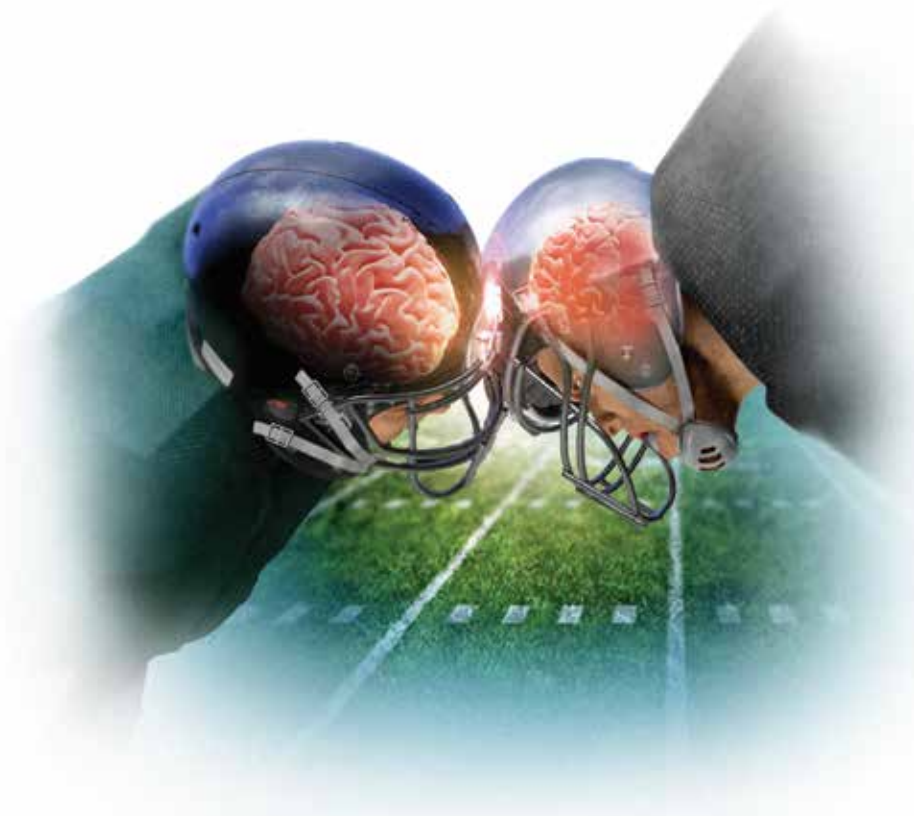
Each year in the United States, more than 44 million young people participate in sports activities.<sup>1</sup> Yet the number of concussions incurred annually by children and adolescents engaged in sports and recreational play has been underestimated for years, and largely unknown.<sup>1,2</sup>

Some estimates were based solely on the number of young athletes treated in emergency departments or sports concussion clinics. Others focused only on team players of middle school or high school age, excluding younger children who were hit in the head on playgrounds or during other recreational activities. What's more, large numbers of concussions—as many as 4 in 10 incurred by high school athletes—were never reported to a coach or medical professional.<sup>3</sup>

In a new study published in the journal *Pediatrics* in June, researchers used national databases and current literature to provide what they believe to be “the most accurate and precise estimate of youth concussion” thus far: Between 1.1 and 1.9 million sports- and recreation-related concussions occur among US youth ages 18 or younger annually.<sup>1</sup>

Among young people playing team sports, concussions are between 2 and 7 times more likely to occur during competitive games than in practice sessions.<sup>4-7</sup> Boys on football and ice hockey teams have the highest rates of concussion in young athletes. For overall number of concussions, however, girls on soccer teams are second only to football players.<sup>4</sup> Female soccer players are more likely than male soccer players to sustain concussions during equal number of hours of play.<sup>4,7</sup>

■ **An increase in incidence.** The incidence of concussion among young athletes appears to have increased in the past decade, a likely result of greater involvement in team sports, an increasing focus on safeguarding young people from the potential dangers associated with a blow to the brain, and better diagnostic techniques.<sup>4,8-10</sup> And a recent study based on data from electronic medical records at a large regional pediatric health care network found that more than three-



Standardized protocols for managing sport-related concussions have been adopted in most clinical settings. But use among primary care physicians is inconsistent.

quarters of young people with sports-related concussions were first seen in a primary care setting.<sup>2</sup>

With this in mind, we present a comprehensive update of the evidence regarding the diagnosis and management of sport-related concussion. The recommendations we include are consistent with professional association guidelines.<sup>8-10</sup> Although we focus on concussion in children and adolescents involved in athletic activities, the principles generally apply to patients of all ages and to concussions that may not be sports related.

### Removal from play: A vital first step

Whenever you conduct a physical exam for a young athlete, remind him or her—and the patient's parents—that after a blow to the head, immediate removal from play is critical. Concussion is caused by a direct or indirect force to the brain that results in a transient disturbance in brain function,<sup>8-10</sup> manifested by alterations in neurocognitive and motor function. While the signs and symptoms (TABLE 1)<sup>8-10</sup> resolve within 10 days of injury in about 90% of cases, those who incur additional head impact within 24 hours have a higher symptom burden and prolonged recovery period.<sup>11</sup> Even with-

out repetitive impact, younger athletes may take longer to recover.<sup>8-10</sup>

### The initial assessment

A child or adolescent who sustains a suspected concussion should be seen by a physician within 24 to 48 hours. Whether the initial assessment occurs in your office or on the sidelines of a game, it is important to confirm the time the incident occurred and the mechanism of injury.

Concussion is diagnosed by a combination of history, physical exam, and objective testing when symptoms or exam findings associated with mild brain trauma—headache, dizziness, light and/or noise sensitivity, among others—closely follow a head injury.<sup>8-10</sup> Certain maneuvers—assessing eye movements by asking the athlete to look in various directions, for instance, then to follow a pen or finger as you move it closer to his or her face—may provoke dizziness, headache, or other symptoms of concussion that were not apparent initially.

The differential diagnosis includes cervical musculoskeletal injury, craniofacial injury, epidural and subdural hematoma, heat-related illness, uncomplicated headache and migraine, upper respiratory infection, and vertigo.<sup>8-10</sup>

CONTINUED

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**TABLE 1**

**Concussion: Signs, symptoms, and risks<sup>8-10</sup>**

Common signs and symptoms	Risk factors for concussion or prolonged course
<ul style="list-style-type: none"> <li>• Headache</li> <li>• Dizziness</li> <li>• Light/noise sensitivity</li> <li>• Difficulty sleeping</li> <li>• Difficulty concentrating</li> <li>• Emotional lability</li> <li>• Imbalance</li> <li>• Amnesia</li> <li>• Confusion</li> <li>• Fatigue</li> </ul>	<ul style="list-style-type: none"> <li>• Female gender</li> <li>• History of migraine/chronic headache</li> <li>• Learning disabilities</li> <li>• ADHD</li> <li>• Mood disorder</li> <li>• Prior concussion</li> <li>• Greater number/severity of symptoms</li> <li>• Loss of consciousness &gt;1 min</li> <li>• Post-traumatic amnesia</li> <li>• Younger age</li> </ul>

ADHD, attention deficit hyperactivity disorder.

**➤ Reserve neuroimaging, such as CT and MRI, for patients with more serious clinical findings or symptoms that persist longer than expected.**

**Tools aid in diagnosis**

Many clinical assessment tools exist to aid in the diagnosis of concussion (TABLE 2).<sup>8-10,12-14</sup> Any one of these tools, many of which use combinations of symptom checklists, balance exams, and cognitive assessments, may be included in your evaluation. No single tool has been found to be superior to any other.<sup>8-10</sup> A combination of tools may improve diagnostic accuracy, but assessment tools should not be the sole basis used to diagnose or rule out concussion.

Any child or adolescent who had a blow to the head and at least one sign or symptom of concussion should be evaluated as soon as possible and assessed again later that day or the next day if any reason for concern remains.

■ **Neuropsychological (NP) testing** may involve computerized tests developed specifically for athletes. Patients may be required to react to objects that appear on a screen, for example, in a way that tests memory, performance, and reaction time. Because cognitive recovery often lags behind symptom resolution, NP testing may identify subtle brain deficits even in athletes who are asymptomatic at rest or with exercise. In general, NP testing has a sensitivity of 71% to 88% for athletes with concussion,<sup>10</sup> but it is most beneficial when baseline test results are available. Interpretation of NP testing should be done only by qualified clinicians.

While NP testing may provide additional prognostic information, it should not alter the management of athletes who are symptomatic either at rest or with exercise.<sup>15</sup> Nor is NP testing vital, as concussion can be accurately diagnosed and adequately managed without it.

■ **Neuroimaging**, including computed tomography (CT) and magnetic resonance imaging (MRI), is often used unnecessarily in the initial assessment of a patient who sustained a possible concussion.<sup>8-10</sup> In fact, neuroimaging should be reserved for cases in which it is necessary to rule out more serious pathology: intracranial or subdural hematoma or a craniofacial injury, for example, in patients with clinical findings that are red flags. These red flags include focal neurologic deficits, continuing nausea/vomiting, or persistent disorientation (TABLE 3),<sup>8-10</sup> or symptoms that worsen or persist beyond a few weeks. In such cases, further evaluation—with MRI of the brain, formal NP testing, and/or referral to a neurologist, psychiatrist, or other physician who specializes in concussion care—is indicated.

**Concussion management: Rest is key**

While there is a dearth of high-quality studies on the management of sport-related concus-

TABLE 2

Concussion assessment tools<sup>8-10,12-14</sup>

Tool	Sensitivity (%)	Specificity (%)	Component(s)
PCSS/GSC			Symptom checklist (measures timing and severity of common symptoms)
9 Item	68	N/A	
17 Item	89	100	
19 Item	64-89	91-100	
Maddocks questions	32-75	86-100	Orientation questions (eg, who scored last? Did your team win the last game?) asked on sports sideline
SAC	80-94	76-91	Orientation questions, immediate memory, concentration, delayed recall (testing on sports sideline)
BESS	34-64	91	Balance testing (athlete asked to assume various positions)
SCAT-2 (SCAT-3, Child SCAT)	83-96	81-91	GCS, Maddocks questions, symptom checklist, SAC, BESS (rates symptoms, mood, etc, over course of recovery)
NFL SCAT	N/A	N/A	Risk factors, symptom checklist, red flags, SAC, BESS (assesses need for immediate disqualification, screens for more serious trauma)

BESS, balance error scoring system; GCS, Glasgow Coma Scale; GSC, graded symptom checklist; N/A, not available; NFL, National Football League; PCSS, post concussion symptom scale; SAC, standardized assessment of concussion; SCAT, sideline concussion assessment tool.

sion across all age groups, standardized protocols for both children and adults have been adopted in most clinical settings.<sup>8-10,16,17</sup> The protocols provide a framework for an individualized treatment plan. Yet their use among primary care physicians is inconsistent.<sup>18-20</sup>

Traditionally, concussion management begins with relative physical and cognitive rest to allow the brain time to recover.<sup>8-10</sup> Recent randomized controlled trials have challenged this premise by suggesting that mild to moderate physical activity for post-concussion patients who are mildly symptomatic does not adversely affect recovery.<sup>21,22</sup> These studies have significant limitations, however, and further research is needed to provide specific guidance on this aspect of concussion management before it is adopted.

■ **Physical restrictions** include organized sports, recreational activity, recess, and physical education classes. Walking is permitted unless it exacerbates symptoms. These restrictions should continue until the patient is symptom-free.

■ **Cognitive restrictions** include modifications at school and at home. Once an athlete is able to concentrate and tolerate visual and auditory stimuli, he or she may return to school. But classroom modifications should be considered, possibly including shortened school days, extra time for testing and homework, help with note taking, and restrictions from classes likely to provoke symptoms, such as computer science or music. Limiting use of mobile devices, television viewing, noisy environments, and other possible provocations may help speed symptom resolution. These restrictions, too, should remain in place until the patient is symptom-free.

■ **Driving** is often not addressed by physicians managing the care of athletes with concussion, but evidence suggests it should be. A study of patients presenting to the emergency department found that within 24 hours of a concussion diagnosis, individuals had an impaired response to traffic hazards.<sup>23,24</sup> And Canadian clinical practice guidelines recommend that athletes with mild traumatic brain

Recent trials suggest that mild to moderate physical activity for mildly symptomatic post-concussion patients does not adversely affect recovery.

**TABLE 3**  
**Red flags that further testing is needed<sup>8-10</sup>**



**TABLE 4**  
**Managing symptoms<sup>8-10</sup>**

Symptom	Management
Headache	Acetaminophen (<3 days)
Nausea	Ondansetron (<3 days)
Dizziness	Vestibular rehabilitation
Insomnia	Sleep hygiene, melatonin
Neck pain	Ice, heat, massage
Light sensitivity	Sunglasses
Noise sensitivity	Ear protection

injury (TBI) avoid driving within the first 24 hours.<sup>25</sup>

While American guidelines are silent on the question of driving for this patient population, we recommend that athletes with concussion be restricted from driving and engaging in other risky complex tasks, such as welding or shop class, for at least 24 hours. For many athletes diagnosed with concussion, driving restrictions of longer duration may be necessary based on their symptom profile and neurocognitive test results. Continued dizziness or visual deficits would pose a greater risk than fatigue or short-term memory loss, for example.

**Overseeing the return to play**

Return-to-activity progression follows a stepwise protocol, with 6 steps that the injured athlete must complete before resuming full activity (FIGURE 1A).<sup>8-10</sup> This stepwise progression begins only when athletes are symptom free, even during provocative maneuvers;

have had a normal neurologic exam, are back to school full time with no restriction; are off any medications prescribed for concussion symptoms (TABLE 4),<sup>8-10</sup> and when neurocognitive testing, if performed, is back to baseline. If an athlete develops symptoms at any stage of the progression, rest is required until he or she remains asymptomatic for at least 24 hours. The progression is then restarted at the last stage at which the patient was symptom free.

Some individualization, of course, is recommended here, too. Younger athletes and those with a prior history of concussion may require 10 days or more to complete all the steps, allowing an extra day at various steps. Neurologic maturation affects recovery time, and for younger individuals, a more conservative return-to-play protocol based on initial concussion symptom duration has been proposed (FIGURE 1B).<sup>16</sup>

Return to activity is often supervised by a certified athletic trainer at the athlete's school. In the event that no athletic trainer is available, patients may be referred to physical therapists with experience in monitoring injured athletes.<sup>26</sup> Anyone involved in the patient's care, including the athlete himself, may use a symptom checklist to monitor recovery.

Although there is no evidence that the ongoing use of a symptom checklist affects the course of recovery, its use is often helpful in identifying specific symptoms that can be managed by means other than physical and cognitive rest—a sleep hygiene program for an individual with lingering difficulty sleeping, for example, or the continued application of ice, heat, and massage for persistent neck pain.

Checklist monitoring may be especially helpful for athletes whose symptoms extend beyond 10 days or who have multiple symptoms. Final clearance once all the steps have been completed requires follow-up with a health care provider.

**Is a symptom-free waiting period necessary?**

There is no evidence suggesting a need for a symptom-free waiting period before starting the return-to-play protocol.<sup>10,27</sup> Because

FIGURE 1A

### Standard return to play<sup>8-10</sup>

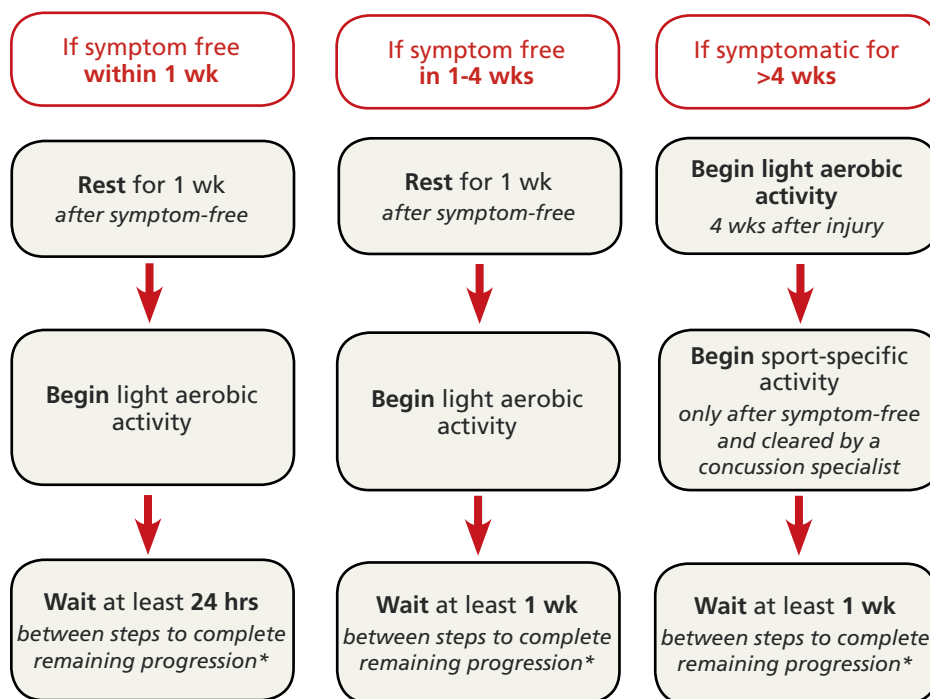
Steps	
1	Complete rest, no activity
2	Return to school full time
3	Light aerobic activity
4	Sport-specific activity
5	Non-contact practice
6	Regular practice
7	Complete activity (includes regular games/matches/events)

Method	
	Each step is separated by at least 24 hours.
	If symptoms occur at any step, the athlete rests until symptoms resolve for 24 hours, then restarts the progression at the last step at which no symptoms occurred.

FIGURE 1B

### A more conservative approach for younger athletes



\*See step-wise progression in FIGURE 1A.

Adapted from: DeMatteo C, et al. *Clin Pediatr (Phila)*. 2015.<sup>16</sup>

a repeat concussion is most likely within 7 to 10 days of the initial injury,<sup>8,9</sup> however, most athletes should not return to contact play during that time frame, regardless of symptom resolution.

It is helpful to have asymptomatic athletes participate in non-contact activity before the 7 to 10 days are up, however. Doing so can help prevent deconditioning and injury upon return to contact sport, as there is

➤ Allowing asymptomatic athletes to engage in non-contact sports activity less than 7 to 10 days after concussion can help them avoid injury when they are cleared for full play.



**A 50-year follow-up study of individuals who played football in high school found no difference in rates of neurodegenerative disease when compared with age-matched controls.**

evidence of increased risk of lower-extremity injury in the 90 days after concussion.<sup>28</sup>

### What to tell athletes—and parents—about repetitive head trauma

There is growing concern about the long-term risks of concussion and repetitive head impact that may manifest as chronic traumatic encephalopathy (CTE) and chronic neurocognitive impairment (CNI) later in life. Indeed, some data strongly suggest—but do not definitively prove—a relationship between repetitive head injury and chronic neurodegenerative disease.<sup>8-10</sup> You can tell worried patients or parents, however, that the majority of research on CTE and CNI has been based on professional football players.

Studies of long-term effects of soccer heading have shown conflicting results, with some finding cognitive impairment, altered postural control, and anatomic changes of the brain, while others found no effect on encephalopathy, concussion symptoms, or neurocognitive performance.<sup>29-36</sup> Here, too, most studies showing negative effects of soccer heading involved professional athletes.

Repetitive sub-concussive impact in high school football athletes has been found to induce biochemical changes to the brain,<sup>37</sup> but the long-term effects are unknown. And, while concussion in high school athletes has been associated with short-term cognitive impairment, altered neurochemistry, and evidence of increased symptoms on baseline neurocognitive testing,<sup>8-10,38</sup> no studies have linked concussion during middle school or high school with CNI. What's more, a long-term (50-year) follow-up study of individuals who played football in high school found no difference in rates of neurodegenerative disease compared with age-matched controls.<sup>39</sup>

■ **A new study** of high school and college football players (mean age: 17.4 years) presented at the American Academy of Neurology 2016 Sports Concussion Conference in Chicago in July, however, found significant alterations in white matter 6 months post injury.<sup>40</sup> The researchers compared 17 athletes with sport-related concussion with matched controls, using diffusion tensor imaging and diffusion kurtosis tensor imaging as biomark-

ers of brain recovery. The concussed athletes underwent MRI and symptom assessment at 24 hours, 8 days, and 6 months. The controls followed identical protocols.

At the 6-month assessment, there were no differences between the concussed group and the controls in terms of self-reported concussion symptoms, cognition, or balance. However, the concussed athletes had widespread decreased mean diffusivity compared with the controls. Despite the lack of clinical symptoms, the concussed athletes showed significant alterations in white matter “that were related to initial symptom severity ratings,” the authors concluded. These findings have implications both for determination of recovery from concussion and concussion management, they added.<sup>40</sup>

■ **Although there is no way to eliminate** all concussions, limited evidence suggests that improving athletic technique, limiting contact at practices, better enforcement of game rules, and rule changes regarding physical contact may decrease concussion risk.<sup>41-43</sup> Many youth sports organizations have developed policies placing restrictions on head impact during practices and games. Studies are ongoing, too, to see if better headgear—or requiring helmets for soccer players—makes a difference. **JFP**

#### CORRESPONDENCE

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