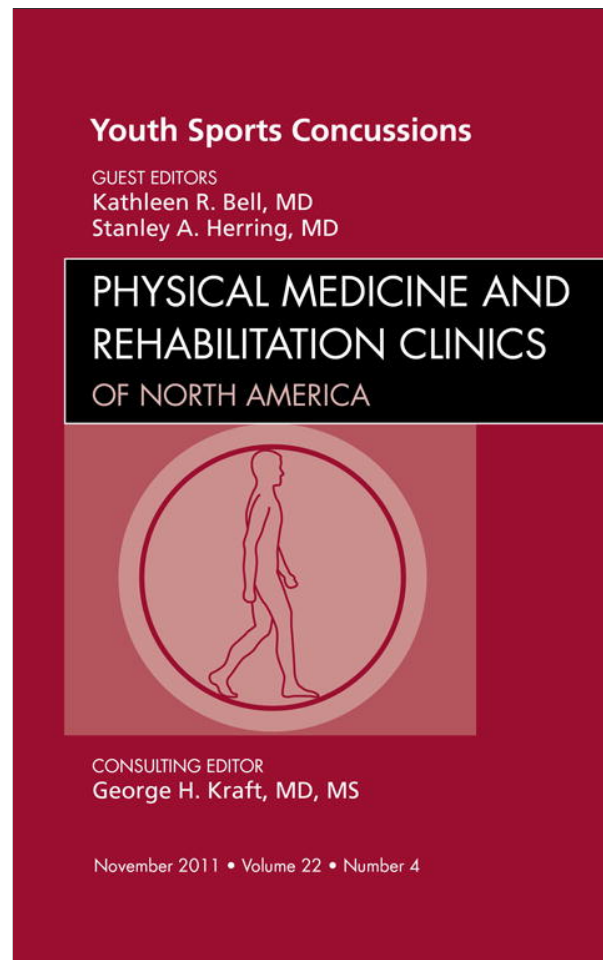


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School and the Concussed Youth: Recommendations for Concussion Education and Management

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KEYWORDS

- Concussion • Mild traumatic brain injury • Student-athlete
- Student • School • Accommodations • Management

Learning is the centerpiece of child and adolescent development. Children's organ of learning is their brain; any adverse event that impairs the brain's functioning, temporarily or permanently, poses a significant threat to learning. Traumatic brain injury (TBI) of any severity is an adverse event that can threaten the developing child's future ability to learn. Although more severe forms of TBI may be readily recognized as a threat, greater attention is being paid now to both short- and long-term effects of TBI at the milder end of the spectrum.¹ Recent advances in concussion research have provided clinicians with numerous means to recognize and assess mild TBI, commonly known as concussion. It is now widely recognized that neurometabolic

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dysfunction is a key aspect of a concussive injury, involving a cascade of neurochemical abnormalities following a force to the brain.² In the wake of this cascade, both physical and cognitive activity become sources of additional neurometabolic demand and stress on the brain. A basic assumption of recovery is that symptom exacerbation after physical or cognitive activity is a signal that the brain's dysfunctional neurometabolism is being pushed beyond its tolerable limits. Management of neurometabolic demands on the brain, therefore, is central to not exceeding the physiologic threshold, thus worsening symptoms and possibly prolonging recovery. Historically, physical rest has been the primary focus of attention in treatment of mild TBI. The focus on physical rest alone, however, does not address mental or cognitive exertion, which is essential for the student's functioning in school. The need for cognitive rest is advocated in the last 2 international consensus statements on concussion in sport^{3,4} and requires explicit attention in the school setting. This article provides a foundation for designing a concussion education and management program in the school setting.

CONCUSSION BASICS

Mild TBI is defined as a direct or indirect force to the head that results in immediate short-lived neurologic impairment (eg, amnesia, loss of consciousness, confusion) that resolves spontaneously, typically followed by physical, cognitive, emotional symptoms and sleep disturbance.⁴ Concussions result in more than 100,000 emergency department visits for children and adolescents each year,⁵ with many more young people with concussion seeking treatment through physicians' offices or not at all. Timely and accurate identification and management of these injuries is especially important in children and adolescents because diagnosis rates have been increasing in high school sports.⁶ Research suggests that adolescents not only are more vulnerable to brain injuries of all severity levels than adults⁷ but also may take longer to recover.^{8,9} There is a dearth of literature on vulnerability to brain injury and outcome in even younger youth. Increased susceptibility to concussion and its effects may be because of less-developed neck muscles for stability, hormonal influences,¹⁰ or greater vulnerability during neural development,¹¹ but there is also something to be said about maturity level and the child's or adolescent's ability to follow treatment recommendations. Young individuals have multiple adults who interact with and care for them throughout each day, such as parents, teachers, guidance counselors, coaches, and athletic trainers. When there is a brain injury of any severity, these individuals must be united in their efforts to bring the young student athlete back to health and full participation in academic, sports, and recreational activities.

Physiologic Effects of Concussion

A basic understanding of the underlying physiologic effects of concussive injury to the brain is helpful in directing treatment efforts for the student in school. Acceleration and deceleration forces shake the brain inside the skull, setting off a complex cascade of shifts in ionic concentrations, release of excitatory amino acids, altered brain glucose metabolism, lactate accumulation, and reduced cerebral blood flow, along with temporary disruptions in neural membranes that, together, result in impaired connectivity, changes in neurotransmission, and a veritable energy crisis.^{2,12} These neurophysiologic changes can be understood as a neurologic "software" problem rather than a "hardware" problem; current evidence suggests that concussive injuries rarely result in identifiable cell death or other structural changes.¹² When the neural software is impaired, the brain attempts to return to its normal state, temporarily forced to use a less-efficient anabolic metabolism. The clinical signs and

symptoms of concussion are believed to be direct manifestations of this underlying neurometabolic cascade. Any additional activity the individual undertakes, whether physical or cognitive, becomes a source of additional neurometabolic demand on the fragile recovering brain system. If that activity becomes excessive, the cycle of inadequate metabolism and energy is perpetuated, and symptoms worsen. Indefinite prolonging of this energy crisis may have additional consequences to neuronal integrity. Therefore, activity levels must be carefully managed in students to facilitate a fast and effective recovery.

RECOVERY FROM CONCUSSION

Recovery from concussion is a process along dual continua of severity and time. Severity is multidimensional and includes not only the number and type of symptoms but also the individual's sensitivity to physical and cognitive exertion. Time can be defined in terms of early postinjury (usually the first few days) and later weeks. There are multiple preinjury and injury characteristics that have been found to influence recovery time.^{13–19} Although concussion has obvious effects on learning (eg, reduced energy level, concentration, and short-term memory), there is also increasing evidence that using a concussed brain to learn can worsen concussion symptoms and perhaps even prolong recovery.²⁰

Determining the end point of recovery from a concussive injury is multifaceted and includes several criteria: return of neurocognitive functioning to preinjury levels, return of balance function to preinjury levels, absence of symptoms (or return to preinjury levels) when the individual is at rest, and absence of symptoms when the individual engages in physical or cognitive activity. Each facet of recovery may resolve along a different time line. For example, some individuals report symptom resolution but continue to demonstrate cognitive impairment on neuropsychological testing^{21–27} and/or ongoing metabolic abnormalities.^{28,29} Recovery time is highly variable, from days to weeks to months, and is not easily predicted at the time of injury.³⁰ For example, some studies of high school and college athletes (mostly football players) report recovery of symptoms and neurocognitive functioning within about 7 to 10 days,^{31,32} yet other studies document a substantial proportion of athletes who continue to experience symptoms and/or neurocognitive impairment well beyond this period.^{30,33}

Multiple factors interact to influence recovery, including premorbid characteristics, the type of sport and/or mechanism of injury, and the age and gender of the individual. Research on predictors of prolonged recovery has been growing, and there is clear evidence that several preinjury and injury factors may prolong recovery, such as premorbid learning disability or attention-deficit/hyperactivity disorder,¹³ anxiety or depression,^{14–16} experience of headache,^{17,18} presence of amnesia or loss of consciousness, or previous concussion.^{17,19}

Effects of Concussion on Learning

Concussion has both direct and indirect, and often striking, effects on learning. The symptoms themselves can make efficient processing difficult. The physical/somatic symptoms of concussion, including headache, blurry vision, light/noise sensitivity, and fatigue, can affect a student's ability to function in the classroom. Sleep disruption during childhood and adolescence is related to cognitive, behavioral, and mood changes,³⁴ and sleep disturbance is not uncommon after concussion. In addition, difficulty falling asleep and increased need for sleep can make staying awake and alert in class difficult.

A relatively understudied but important phenomenon is the impact of emotional symptoms on learning after a concussion. Clinical experience indicates that anxiety can be both a direct and indirect effect of concussion, and anxiety symptoms can further impair cognitive functioning as well as interfere with students' compliance with treatment recommendations. Adolescents in particular have a tendency to try to "work through" their symptoms because the stress associated with missing class or not completing their work can seem, in the short term, more unbearable than the symptoms. In addition, experiencing prolonged recovery can lead to or exacerbate emotional symptoms (eg, frustration, anxiety, depression), which may in turn negatively affect individuals' perception of their cognitive functioning.³⁵

The cognitive symptoms of concussion include feeling foggy or slowed down and difficulty concentrating or remembering. There are also measurable effects of concussion on cognitive functioning, including decreased learning and memory, decreased attention, and slowed processing speed and reaction time.^{36,37}

Effects of Learning on Concussion

In addition to the cognitive symptoms that are often experienced after concussion, engaging in cognitive activity (eg, attending class, reading, studying) is hypothesized to stress the already underenergized brain, resulting in worsening of symptoms and potentially prolonged recovery.²⁰ The experience of worsening symptoms following cognitive activity has been referred to as the effects of cognitive exertion, although it may be more appropriately termed as the effects of cognitive over-exertion. In fact, the concept of cognitive exertion can be represented on a continuum that ranges from no activity (ie, full rest) to full activity (ie, no rest). The therapeutic goal during concussion recovery is to find an appropriate level of cognitive exertion that does not exacerbate symptoms or cause the reemergence of previously resolved symptoms.³⁸ It is unlikely that this goal would entail complete rest, but instead a level of cognitive activity that is below one's symptom threshold (ie, subsymptom threshold).

Cognitive overexertion is very commonly reported in clinical settings,³⁹ and its prevention is of utmost importance. In a group of students who sustained concussions and were treated in the authors' clinic ($n = 72$), more than 80% reported increased postconcussion symptoms after cognitive exertion 1 month after injury.¹¹ In contrast, in this sample of students, less than 40% reported an increase in symptoms with physical exertion. One factor contributing to this difference was the greater number of restrictions placed on students' physical activity (43% reported restrictions) versus their cognitive activity (only 3% reported restrictions).

The antidote to cognitive overexertion is cognitive rest, which has been identified as one of the cornerstones of concussion management⁴ and involves avoiding excessive demand on neurometabolic processes associated with cognitive activities. Similar to the instructions a physician would provide to an athlete to avoid bearing weight on an injured ankle or knee to promote recovery, the concept of cognitive rest involves avoidance of mental challenges during the initial postconcussion stage. A careful balance between cognitive activity and rest is paramount in these early stages of recovery and beyond. Children and adolescents, with the help of adults involved in their care, should maintain a level of cognitive activity that does not make symptoms worse or reappear³⁸ to avoid exacerbating symptoms and possibly delaying recovery.^{4,39,40}

The level of activity that is tolerable (ie, does not worsen or create symptoms) is unique for every individual and changes throughout the course of the recovery time line, both as time passes and symptoms resolve or change, and as the individual's sensitivity to activity changes. For example, for a highly symptomatic individual in

the early stages of recovery who is sensitive to environmental stimuli (eg, noise, light), rest may mean lying in a dark quiet room. Particularly early on, cognitive rest may require a student to refrain from almost all activities that involve cognitive exertion, such as working on a computer, watching television, using a cell phone, reading, playing video games, text messaging, or listening to loud music. Some student athletes may need a full- or part-time hiatus from school while symptomatic.^{4,40} For another individual further along in recovery who is less severely symptomatic and less sensitive to environmental stimuli, light reading or short periods of television or listening to music can be relaxing. One challenge in managing activities to reduce symptoms is that many student athletes have difficulty complying with instructions to limit or completely avoid cognitive activities because these activities are routine parts of their day, used to avoid boredom and to communicate with teammates and friends. For parents and other adults managing a child's activities after a concussion, prescribing and enforcing limitations require striking a careful balance between prioritizing rest while still allowing some activities in short bursts, provided these activities do not make symptoms worse.

Proactive management of activities is likely beneficial for recovery, although prospective studies of activity management and recovery have not been conducted in humans. In rats, early postinjury physical activity (within the first 2 weeks) led to lower learning and memory performance and reduction in plasticity-related proteins, whereas rats that engaged in activity later in recovery showed improved learning and memory.⁴¹ In humans, a retrospective chart review found that higher levels of cognitive and physical activity during recovery were associated with greater neurocognitive deficits and higher symptom reports.²⁰

RETURN TO ACTIVITIES FOLLOWING A CONCUSSION

Return to Cognitive Activity

Concussion management guidelines have begun to appreciate the effects of cognitive exertion on concussion symptoms and management,^{3,4} and the process of academic return is gaining attention in scientific literature, the press, and legislation. Careful management of neurometabolic demands on the brain during recovery, including what is needed for cognitive activity, must avoid exceeding the threshold that produces symptom exacerbation. Children and adolescents spend most of each day engaging in cognitive activity, from classroom work and note taking to homework, and from video games to texting and social networking. Although some of these activities take place at home, many of them occur in the school environment. Thus, school personnel must play an important role in managing these cognitive activities to facilitate concussion recovery. A school with concussion policies and procedures implemented before a student sustains an injury is better prepared to manage a successful return. The basic components of a school-based concussion management plan, including who should be involved and appropriate interventions, are outlined in the following section. Although there is no plan that works for everyone, there are certain symptom and neurocognitive presentations that indicate a need for accommodations, and these are discussed in more detail in the final section of this article.

Return to Physical Activity

Students with a concussion must be restricted from physical activity, sports, and playground activity until a health care professional with expertise in concussion evaluation and management provides clearance for the student to return to play. This restriction

is to first protect the student athlete from sustaining another blow to the head and already more vulnerable brain. A second blow can lead to catastrophic injury or, at the very least, significant worsening of symptoms and/or considerably prolonged recovery. Another reason for restricting activity is that physical activity can cause symptoms to worsen during the early stages of recovery. Protocols for returning to physical activity, including recess, physical education (PE) class, recreation, and sports, include graduated steps to increase activity levels while ensuring that symptoms do not worsen or return at each step before progressing to the next level.

The gradual return-to-play protocol for sports activity typically begins after complete resolution of symptoms at physical rest and no symptom return with cognitive exertion. It is essential that school and medical personnel communicate with coaches, PE teachers, and athletic trainers about the student's cognitive progress when planning a return to physical activity. Students should be able to participate in their typical academic activities, including attending full days of school and completing work without accommodations, with no return of symptoms, before return to play is considered. This provides important information about the postconcussion neurometabolic status of the student athlete's brain.

At the 2001 Vienna consensus meeting of the International Concussion in Sport Group, concussion recovery strategies focused on a graduated program of return to physical activity.⁴² Athletic trainers and sports medicine physicians have been instrumental in promoting and facilitating these protocols. General guidance for having a student athlete return to sports, PE class, or recess may include transitioning the injured student from no participation to limited participation, by gradually engaging only in low-risk drills or activities or playing with increased adult supervision. The gradual return to play in sports takes place in 5 progressive steps,⁴² with careful monitoring for return of any post-concussive symptoms at each stage. The first step begins with light physical activity not involving any jarring of the head (eg, walking, elliptical, or stationary bicycle) for relatively short periods. The second step involves an increase in the intensity and duration of activity, introducing movement such as jogging and sports-specific drills. The third step continues to increase the intensity and duration of physical activity incorporating movement in all 3 planes (forward-backward, side-to-side, and up-and-down). Choice of activities in each of the first 3 steps should be made with minimal risk of reinjury. The fourth step involves the athlete participating in controlled scrimmages or other supervised contact play. The final step is participation in full contact competition, where appropriate. Return to play for nonathletes, for whom a systematic plan of gradual return is not readily built in, necessitates a more creative program that might be conducted by an athletic trainer or sports physical therapist to ensure that engaging in physically challenging activities does not result in return of symptoms.

CONCUSSION PROGRAMS IN SCHOOLS

There is a need in schools across the country for widespread concussion awareness, education, and management programs. Although several states have passed legislation and implemented policies regarding education and management of athletic return to play for injured student athletes, less attention has been given to formal policies and procedures that support the recovery of the student role of the student athlete. In an attempt to address this gap in policy, legislation has been introduced in Congress by the Education and Workforce Committee that, in addition to providing return-to-play guidelines, outlines necessary education and policies needed for managing concussions' effects on learning and school participation.⁴³ Regardless of whether such

legislation passes, structured programmatic changes in schools are needed because many are simply not prepared to assume management of students with concussion. To help the authors understand the magnitude of this need, parents of students with concussions seen recently in their clinic ($n = 49$) were asked about their child's return to school after injury. Of those surveyed, only 24% reported that they were aware of a written plan for concussion management at their child's school, and it is unknown whether these plans included academic accommodations and return to cognitive activities as opposed to return to play, the latter of which is the focus of most existing plans. Almost half of the parents (43%) were moderately or very concerned about their child's return to school, and 38% worried that their child's grades had been or would be affected after the injury. Most parents surveyed (70%) indicated that their child needed some kind of support on returning to school, with the most commonly endorsed accommodations being rest breaks and extra time for assignments and tests. Almost a quarter (23%) of parents who stated that their children need support were not sure what form that might take, highlighting the importance of including medical and academic professionals in the development of a temporary accommodation plan specific to each injured student.

There are 3 steps to designing and implementing a concussion program in a school: (1) establishing policies and procedures, (2) educating school personnel, and (3) implementing the plans for students who sustain concussions. Just as in other accommodation-based educational plans, the plan for each student with concussion requires individualization, involving the cooperation and creativity of multiple school personnel and ongoing assessment and adjustment of the plan throughout recovery. The various steps occur in a specific timeline throughout the course of the school year, with development of the policy and procedures and education conducted before the school year, review and monitoring of policies and concussions throughout the year, and active management being implemented as soon as an injury is suspected or identified. **Table 1** outlines the various processes described along this time line, with delineation of responsible parties, when various steps should be completed, and the benchmarks for completion.

Policies and Procedures

The first step in school-based concussion education and management is to develop policies and procedures to help returning students succeed as they recover from a concussion. As noted in the Centers for Disease Control's (CDC's) "Heads Up to Schools: Know Your Concussion ABCs" toolkit,⁴⁴ policy statements should include the following: (1) school's commitment to safety, (2) a brief description of concussion, (3) a plan to help students ease back into school life (learning, social activity), and (4) information on when students can safely return to physical activity after a concussion. To ensure that concussions are identified early and managed effectively, an action plan must be in place before the start of the school year based on the policies and procedures. All appropriate school and athletic staff should know about the plan and be trained to implement it.

The school policy should describe how to create and maintain safe school environments. All school staff and administrators must be encouraged to keep the physical space safe, stairs and hallways clear of clutter, rugs secured to the floor, and the surfaces of all areas where students are physically active, such as playing fields and playgrounds, safe. Additional safety considerations regarding concussion prevention can include a commitment to appropriate use of safety equipment (eg, helmets) and instruction in safe playing techniques (eg, tackling and checking approaches to reduce the chances of injury). Descriptions of concussion should be generated from scientific

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.

literature, with emphasis on how to recognize concussions and their signs and symptoms.

An essential part of the plan to help students ease back into school life is to identify the key personnel and the roles each will play to support the student's return. Key team members include the school nurse/health aide, school counselor, school psychologist, speech/language pathologist, and school administrator. In addition, all school staff must understand the general principles for supporting the student's return, including classroom teachers, PE teachers, coaches, and staff who supervise free time such as lunch and recess. Supporting a student recovering from a concussion requires a collaborative approach among school professionals, health care professionals, parents, and students. School policies should specify how school personnel will be informed about a returning student's injury and specific symptoms and ways they can assist with the student's transition process and making accommodations for a student. Existing mechanisms for supporting students such as response to intervention (RTI) services or a 504 plan should be considered. An RTI approach is an active, collaborative, problem-solving approach amongst the teaching staff, student, and parents that dynamically assesses the student's needs, designs the necessary academic and/or behavioral interventions, continuously monitors the student's progress, and adjusts the interventions accordingly to meet the student's needs. Section 504 is an educational support mechanism that is implemented when students have a defined disability (temporary or permanent) that affects their academic learning and performance. The return-to-physical-activity team must be able to monitor activities, symptoms, and cognitive and balance testing or conduct consultation with professionals who have training in concussion management and the administration and interpretation of test results.

Education

The second step in developing a schoolwide or systemwide concussion management program involves educating school personnel about (1) concussions and their effects and (2) each professional's role in management when an injury occurs. Ideally, education about concussion would occur before the start of the school year so that teachers, counselors, administrators, coaches, and nurses alike are prepared to identify a concussion when it occurs. Participants should also learn about the potential long-term effects of concussion and the dangers of returning to activity too soon. The more people know about a concussion before it happens, the more likely it is that the concussion will be managed correctly from the start, reducing potential complications from returning to activities too soon. To aid in information dissemination, the CDC has published a toolkit of educational materials for school personnel⁴⁴ that parallels the materials available in the physicians' toolkit.⁴⁵ These materials highlight the symptoms and recovery course of students as they apply to the school setting and provide a starting point for concussion education.

Intervention/Management Plans

In tandem with concussion education, a schoolwide management plan should be implemented with review and updating each year before the start of the school year. A model program, developed by school and medical practitioners in Colorado, is entitled REAP (for Reduce, Educate, Accommodate, Pace) and includes structured guidelines for the role of parents, students, school academic teams, school physical activity coordinators, and medical professionals in return to both physical and cognitive activities after concussion.⁴⁶ Because no two concussions are the same, there is not a "one size fits all" plan, but there should be a team assembled with clearly defined

roles. Each effective management plan must involve injured students, their parents, and a carefully coordinated team of school personnel. The members of the school team vary based on school resources but typically include some combination of the athletic trainer, guidance counselor, school nurse, all teachers, and the school psychologist or social worker as needed.⁴⁷ One person (eg, nurse or athletic trainer) should regularly track symptoms, looking for improvement or worsening, and communicate changes to the rest of the team. The student's guidance counselor or school psychologist is essential for coordinating accommodations and using the symptom log to guide adjustments.⁴⁷ In addition to self-reported symptoms, the injured student's teachers should attend to the existence of the cognitive effects of injuries: increased problems paying attention or concentrating, increased problems remembering or learning new information, needing longer to complete tasks or assignments, greater irritability and less tolerance for stressors, and an increase in symptoms (eg, headache, fatigue) when doing schoolwork.⁴⁴

Throughout the course of recovery, it is essential that student athletes receive a consistent message from all school staff about expectations and accommodations during recovery. As soon as a student is identified as having sustained a concussion, symptoms should be assessed. The first decision must then be whether the student should or should not attend school. The model often used, in which students attempt to return for full days while still symptomatic without school personnel knowing their status, is a trial and error approach that too frequently results in error. A highly symptomatic student should be kept home to rest because it can be reasonably assumed that attempts to participate in academic activities will only worsen symptoms. Depending on symptom status, students can be sent home with some schoolwork to try in small blocks of time to help determine whether and when they are able to participate in cognitive activity. Some students return to school with specific recommendations from a concussion professional, which can be implemented according to the school's resources. If specific recommendations are not made by a concussion professional, the academic team coordinator should proactively develop a schedule with breaks and reduce the student's workload before symptoms are exacerbated. Students who are not already seeing a concussion professional for follow-up should be referred to such a professional if the student cannot manage cognitive demands or if cognitive rest does not facilitate recovery.

COMPONENTS OF A SUCCESSFUL GRADUAL RETURN TO COGNITIVE ACTIVITIES

By assessing symptoms and, when possible, neurocognitive status at the outset, proactive modifications to the school schedule can help prevent the effects of cognitive overexertion. Expectations can then be increased in a gradual, stepwise manner as symptoms allow. A systematic program of gradual return to academic demands after a concussion is important for several reasons. First, this program assures that cognitive demands are below the symptom threshold (ie, not of the duration or intensity to cause symptoms to return or increase). Second, there may be psychological benefits (eg, lowered stress) in reassuring injured students that they can handle the return to school. The concept of the gradual return applies to most, if not all, returning student athletes, but the implementation of the gradual return needs to be both individualized and able to change over time as the child recovers.⁴⁷ Some gradual returns may be quite rapid (eg, a student demonstrates ability to manage increasing amounts of studying through the weekend), whereas others will be prolonged (eg, a week or more attending only a class or two during the day). In those students with more severe symptoms and more prolonged restriction from school, a gradual return reinforces

their ability to handle smaller amounts of schoolwork, thereby reducing the stress and anxiety caused by returning to academics. For a child who also sustained other physical injuries along with concussion, a partial return to school could also provide benefit to help with medication management for pain or orthopedic needs (eg, crutches, wrist splints, and so forth).

Practical Considerations

The timing and rate of return to school must be monitored carefully on an individual basis. Although a student who has already missed a prolonged period of school because of significant symptoms may need to return at a slow and gradual pace, sometimes an initial period of complete rest facilitates return to a full schedule of academics quickly. Alternatively, someone who has prematurely returned to school and kept pace with schoolwork despite active symptoms may require a longer period of restricted academics and a more gradual return to facilitate recovery.

Effective communication from medical professionals to school personnel regarding return to academic activities is important. Forceful requests may be met with resistance. However, most teachers are open to guidance, and reasonable recommendations as to how best to help the injured student return successfully will have a greater chance of successful implementation. To maximize successful return to school and minimize negative events, careful collaborative planning is important.

The primary guideline for helping a student return to school is the symptom pattern. As previously discussed, emerging or increasing symptoms are an indication of cognitive overexertion, that is, too much demand on the brain's dysfunctional metabolism. The workload or activities, therefore, should be reduced to keep symptoms from increasing. Remaining below the symptom threshold (ie, subsymptom threshold) is the therapeutic goal such that the physical or cognitive demands (or combination of the two) do not cause symptoms to return or worsen. Thus, most activities (except, of course, those with a potential risk of a re-injury) that do not cause symptoms to increase should be allowable as long as rest breaks are taken at the point when, or ideally just before, symptoms emerge or worsen. It is important to reinforce that all types of activities-cognitive, physical, emotional, and social-may bring individuals closer to their symptom threshold. This threshold is different across individuals and changes over the course of recovery. Another role, primarily for the medical professional, is to help arrange the environment in a way that allows for students to do as much "normal activity" as possible without crossing their individual symptom threshold. Some general modifications are provided in the following sections, but a careful assessment of symptoms, and creativity on the part of the clinician, is important for an individualized recovery plan.

Scheduling Considerations

When planning for the return to school, parents may test the symptom threshold at home by having children do work for set periods (eg, 15, 30, or 45 minutes) to see how long they can sustain concentration without increased symptoms. On returning to school, modifications may include abbreviated time at school, scheduled rest breaks (and/or self-initiated rest breaks with a pass to leave class whenever symptoms flare), and modified or limited coursework or tests. Different teachers approach academics and students from different perspectives, and finding classes that are most meaningful to students and teachers who are the most understanding and supportive may be the best classes for students to begin their return. This is not, however, always the case. Some teachers may be less forgiving of missed class time, and it may be better for the student to return to that setting to avoid the added stress of a potentially

negative evaluation. This may also be an opportunity for school administration to educate and counsel the teacher on appropriate postinjury expectations.

Accommodations for Neurocognitive Deficits

The neurocognitive deficits associated with concussion include decreased reaction time or speed of processing, concentration problems, short-term or working memory deficits, problems with new learning and memory consolidation, and cognitive fatigue. These problems interfere with school performance and require explicit accommodations. For example, concentration or memory problems suggest the need for limited, modified, or no testing at that stage of recovery. Slowed processing speed suggests a need for additional time to complete work and review material. **Table 2** summarizes the link between neuropsychological deficits and functional school problems, with suggested accommodations.

Symptom-Specific Considerations

In addition to the general guidance for sports and academic activities, careful attention to specific symptoms and situations that may make symptoms worse is important. Individuals with different types of primary symptoms may require different accommodations, which also are summarized in **Table 2**. High levels of somatic symptoms may call for environmental adjustments. For example, a student who experiences headache onset or worsening with cognitive activity should be allowed to leave class to rest whenever needed. The school nurse should be involved in careful monitoring of headaches and pain medication use in these students because students should not return to class if the only way they can tolerate cognitive activity is to take medicine. A student who is sensitive to noise may need to avoid eating in the cafeteria during lunchtime or should consider traveling between classes outside of the usual between-class times. Children with dizziness or complaints of balance problems may need a pass to travel between classes before the usual time to avoid injury in crowded hallways. Accommodations for students who are experiencing fatigue should carefully consider scheduling. Even for students who are not displaying neurocognitive deficits, performance can decrease over time. For a student who is ready to take examinations, teachers should offer reduced or modified testing (eg, space out finals so that there is only 1 per day, administer tests in multiple short sessions, allow some portions to be completed orally).

A student's sleep-related symptoms can influence the decision of which classes to attend when schedule reduction is needed; a student who is experiencing difficulty falling asleep may be allowed to sleep in later, missing their morning classes, with the goal of returning to a normal sleep schedule over time. A student who wakes up symptom free but experiences symptom exacerbation throughout the day may find it more beneficial to attend morning classes and nap or rest in the afternoon before attempting homework.

As described earlier, the concussion itself can result in emotional symptoms (eg, worry, sadness), and the experience of neurocognitive difficulties can further exacerbate emotional difficulties. The student's emotional state needs to be taken into consideration to facilitate a smooth transition back to cognitive activities. Many students experience a decrease in stress and anxiety simply by knowing that the educational team is united and has proactively offered accommodations. Sometimes simple scheduling considerations can help reduce anxiety; for example, a student who is anxious about missing classes may find it helpful to rotate which classes they attend each day in order to attend each subject a few times each week. Students who report

Table 2		
Accommodations for postconcussion effects affecting school		
Postconcussion Effect	Functional School Problem	Accommodation/ Management Strategy
Neuropsychological deficits		
Attention/concentration	Short focus on lecture, classwork, homework	Shorter assignments, break down tasks, lighter work load
Working memory	Holding instructions in mind, reading comprehension, mathematics calculation, writing	Repetition, written instructions, use of calculator, shorter reading passages
Memory consolidation/ retrieval	Retaining new information, accessing learned information when needed	Smaller chunks to learn, recognition cues
Processing speed	Keep pace with work demand, process verbal information effectively	Extended time, slow down verbal information, comprehension checking
Fatigue	Decreased arousal/activation to engage basic attention, working memory	Rest breaks during classes, homework, and examinations
Symptoms		
Headaches	Interferes with concentration	Rest breaks
Light/noise sensitivity	Symptoms worsen in bright or loud environments	Wear sunglasses, seating away from bright sunlight or other light. Avoid noisy/crowded environments such as lunchroom, assemblies, and hallways
Dizziness/balance problems	Unsteadiness when walking	Elevator pass, class transition before bell
Sleep disturbance	Decreased arousal, shifted sleep schedule	Later start time, shortened day
Anxiety	Can interfere with concentration, student may push through symptoms to prevent falling behind	Reassurance from teachers and team about accommodations, workload reduction, alternate forms of testing
Depression/withdrawal	Withdrawal from school or friends because of stigma or activity restrictions	Time built in for socialization
Cognitive symptoms	Concentrating, learning	See specific cognitive accommodations (above)
Symptom sensitivity	Symptoms worsen with overactivity, resulting in any of the earlier-mentioned problems	Reduce cognitive or physical demands below symptom threshold, provide rest breaks, complete work in small increments until symptom threshold increases

emotional symptoms throughout their recovery need support and guidance from their guidance counselor, school psychologist, and/or a private therapist.

Perhaps the most obvious symptoms necessitating school accommodations are those that are cognitive in nature. In general, many accommodations typically

provided for students with other learning and attentional problems may be appropriate temporary accommodations for students recovering from concussion. Students experiencing decreased concentration and memory capacity should be provided with lecture outlines or another student's notes to ease the burden of simultaneous listening and writing. Other accommodations to consider include allowing flexibility in assignment deadlines and postponing tests (particularly high stakes, such as final examinations and Scholastic Aptitude Tests). Time extensions and rescheduling should be weighed carefully against the future burden of a large amount of makeup work. Students who have finally returned to their baseline symptoms and cognitive functioning may regress in their recovery or experience unnecessary stress if faced with this burden. Especially for younger student athletes and those with relatively short recovery times (1–2 weeks), teachers should consider excusing all assignments during acute phase and basing grades on work completed before injury and after recovery. Extra tutoring may be helpful for students who have missed a lot of class time, but, again, caution should be used because facilitating exposure to learning in these ways may increase cognitive demands and cause increased neurometabolic strain. Careful monitoring should be used.

Precautions

The gradual return is not without its challenges. Students who are once again given permission to return to academics in any capacity may take the opportunity to overdo physical and mental activities, despite prescribed restrictions, thus putting them at risk for prolonging their recovery. Students who are present in school may also have a large amount of demands placed on them by well-intentioned teachers who see the presence of the student (and an absence of any external signs of injury) as an indication that they are capable of completing all of their work. Symptoms and neuropsychological deficits can resolve at different times for different people, so teachers should be aware that students who report being symptom free may not yet be able to perform fully at preinjury levels or successfully return to their full workload and schedule. In addition, well-meaning teachers may not appreciate the full scope of the cumulative demands placed on the student athletes by all their teachers. Well-coordinated efforts by school personnel, such as the guidance counselor or school psychologist, can help avoid this problem. A student who is at school and therefore seems available to begin completing makeup work may be asked to stay after school or receive extra tutoring to catch up on assignments. Again, careful coordination among teachers and guidance staff is the best way to avoid these unnecessary burdens.

SUMMARY

Concussions are gaining increased awareness in schools, sports, media, and research, and both personal experience and research data support the fact that these injuries can have a significant impact, at least temporarily, on a child's or adolescent's participation in school, social activities, and sports/recreational activities. A concussive injury is a direct or indirect blow to the head that results in a neurometabolic cascade and ensuing cellular energy crisis in the brain, leaving the brain vulnerable to additional injury during the recovery phase. The ensuing symptoms and neurocognitive effects of concussion affect learning and performance, and many students engaging in cognitive activity shortly after a concussion experience symptom exacerbation and increased difficulty with work completion, concentrating, and remembering. Students who are highly symptomatic and try to maintain full

academic schedules quickly realize that they will need temporary accommodations to prevent falling behind and effects on their grades.

Athletic return-to-play protocols have been a focus of concussion management for quite awhile, with an emphasis on gradual return to physical activities so that reinjury does not occur before full recovery. Legislation regarding the implementation of these protocols has been passed in a growing number of states, making the transition back to sports and recreation both safer and more predictable. In contrast, protocols for return to cognitive activity in school setting are only beginning to gain momentum, and current legislation typically has not included provisions for this process. Whether or not protocols for return to academics are mandated by legislation, to support the recovery and academic needs of the recovering student, systematic efforts must be initiated as soon as possible.

Successful gradual return to cognitive activities requires coordination among school personnel who are educated about the effects of concussions on students and are committed to providing accommodations for the symptoms and neurocognitive deficits that result, continuously monitoring symptoms, and adjusting interventions accordingly until recovery. Team members include a range of school personnel, such as guidance counselor, nurse/health aide, school psychologist, teachers, PE and coaching staff, and athletic trainers, as well as the student, parents, and treating medical professionals. Key personnel would implement a well-developed accommodations plan that is specific to the recovering student's needs as soon as the concussion is suspected or identified. Scheduling and other symptom-specific accommodations would be proactively introduced to reduce the secondary effects of cognitive overexertion. A secondary focus of the plan for professionals could be to coordinate efforts to reduce the student's academic and emotional burden to facilitate recovery. The guidelines presented in this article can assist a school system in the development of its policies and procedures and also help the treating medical professional design a school-sensitive individualized plan.

The benefits of active management of cognitive and physical activities are numerous. Well-supported students can focus on resting and recovering without having to spend excess energy on trying to keep up with their academic workload, fighting for accommodations, or becoming anxious about whether their grades will suffer. Although future research is needed, it is possible that proactive management could reduce recovery times by ensuring less cognitive overexertion and stress, and therefore less misguided energy away from neurometabolic recovery. Involving school personnel in the active and continuous monitoring of cognitive activities and symptoms provides a better determination of symptom resolution both at rest and with cognitive activity. As a secondary benefit, continuous monitoring and active cognitive support can result in safer and possibly speedier recovery, providing important data to assist the decision about when to initiate the athlete's gradual return to sports participation.

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