

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

Neal McGrath, PhD

Sports Concussion New England, Brookline, MA

Objective: This article provides a framework for school athletic trainers to use in advising colleagues about the health and academic needs of student-athletes presenting with concussions.

Background: Management of sport-related concussions has been an area of growing concern for school athletic programs. Recent work in this area has highlighted significant risks for student-athletes presenting with these mild traumatic brain injuries.

Description: Topics covered include general teaching points for the athletic trainer to use with school colleagues. An

integrated model for school management of sport concussion injuries is presented that includes involvement of the student's athletic trainer, school nurse, guidance counselor, teachers, social worker, psychologist, physicians, and parents.

Clinical Advantages: Academic accommodations for specific postconcussion symptoms are proposed that may help the student-athlete strike an optimum balance between rest and continued academic progress during recovery.

Key Words: athletic injuries, mild traumatic brain injuries, academic accommodations, school concussion programs

Athletic trainers (ATs) have devoted increasing attention to the management of sport concussions among student-athletes in recent years as researchers have provided better understanding of the risks of these injuries,¹⁻³ as new assessment tools have been developed,⁴⁻⁷ and as consensus has begun to emerge among sports medicine professionals regarding best clinical practices.⁸⁻¹² Working in school settings under the supervision of their team physicians, ATs usually have the primary responsibility for day-to-day management of student-athletes recovering from these mild traumatic brain injuries. Although the AT's immediate concern is the student-athlete's safety and readiness to resume exercise and contact sport participation after a sport-related concussion, it is also very important to recognize that athletes recovering from concussions face certain predictable challenges in their academic lives in the days and weeks after these injuries. Even when the AT and team physician carefully manage a student-athlete's concussion, school personnel outside of the athletic department may not be aware of the recovering student's needs or of the important role that guidance counselors, school nurses, social workers, psychologists, and teachers—working together with parents and the student-athlete's personal physician—can play in this process to help minimize the academic consequences of the injury.

This article provides an overview of key information for the AT to use in advising school colleagues about concussion recovery. Included are a 5-step model for concussion management within school settings, a review of reasonable academic accommodations for student-athletes in recovery, and suggestions for the implementation of accommodation plans, with an emphasis on the key role played by the AT as a member of the larger educational team.

ADVISING SCHOOL COLLEAGUES ABOUT CONCUSSION RECOVERY

The AT is ideally positioned to be a primary source of information about concussion recovery, not only for the

student-athlete but also for one's school colleagues. Several key teaching points may be useful to help other staff who will be interacting with the recovering student-athlete.

Concussion Incidence

Although sport concussions account for fewer than 10% of total injuries attended to by ATs,¹³ coaches should expect seasonal rates of up to 5% to 10% among athletes participating in contact sports. Coaches whose teams have either no reported concussions or much lower concussion rates should be mindful that concussions may be escaping detection as a result of a lack of awareness of symptoms and risks or the tendency of many student-athletes to underreport these injuries.¹⁴

Loss of Consciousness and Amnesia

Most coaches know that athletes whose concussions involve loss of consciousness should receive immediate medical evaluation.⁹ However, sport concussions do not usually involve a full loss of consciousness.¹⁴⁻¹⁶ Furthermore, a clear relationship between loss of consciousness and postconcussion symptom severity or duration does not seem to exist; athletes who have not lost consciousness but display amnesia for events just before or after the injury are slower to recover than those who lost consciousness but did not have amnesia.¹⁷

Symptoms

In the days or weeks after injury, student-athletes typically present with some combination of physical, cognitive, sleep dysregulation, and emotional symptoms.¹⁸

Return to Play

Expert consensus¹² is that an athlete diagnosed with a concussion should not be allowed to return to play on the

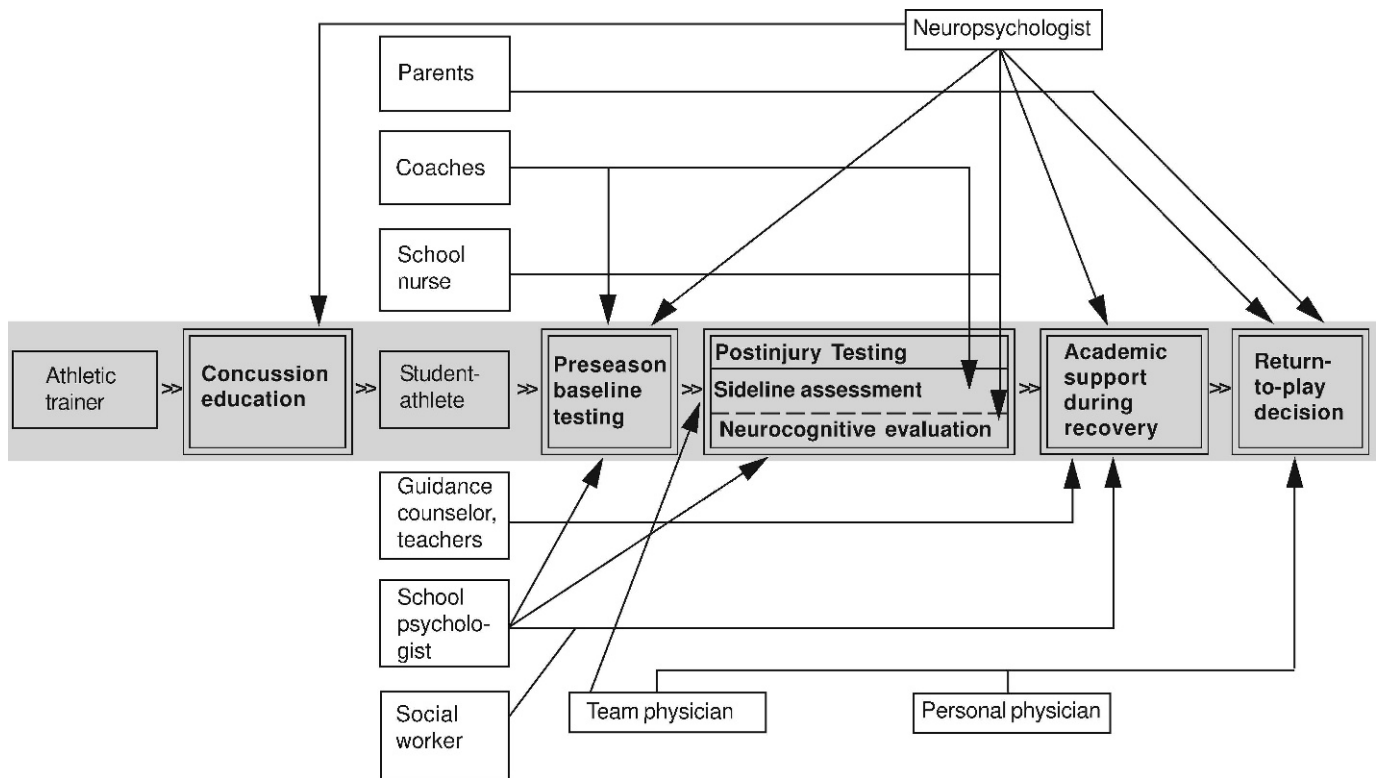


Figure. Model for concussion management in the student-athlete.

day of injury. Premature return to contact sports after a concussion may increase the risk that symptoms will be prolonged for days, weeks, or even months. In rare cases, return to play while the athlete is still symptomatic can result in catastrophic neurologic injury or death in student-athletes, a condition known as second-impact syndrome; high school-aged athletes are most vulnerable.^{1,19,20}

Neurocognitive Testing

Recent developments in the neuropsychological study of sport concussion have led to the use of evidence-based guidelines for determining readiness to return to play.¹⁸ In this approach, neurocognitive testing is used to help determine an athlete's preinjury baseline of cognitive functions in areas such as memory, attention, concentration, reaction time, processing speed, and response accuracy, which are likely to be affected in a concussion injury.^{21–23} Postinjury, not only are recovering athletes monitored until they are symptom free, but before returning to play, they also undergo serial neurocognitive testing until they have regained their baseline cognitive function. This approach offers a significant advance over the use of a grading system alone for 2 main reasons. First, computerized neurocognitive testing is sensitive to the lingering cognitive effects of concussion injuries, even when athletes feel that they are fully recovered.^{24–26} Second, some athletes may minimize or deny concussion symptoms for a variety of reasons, including failure to understand the symptoms and risks of concussion, not wanting to let their teammates down, not wanting to lose their position on the team, or not wanting to appear weak or cowardly to others. Therefore, they may think or claim that they are symptom free and ready to return to play when, in fact, they are not.¹⁴

Schoolwork

Educators should understand that recovering students may not be able to meet the usual expectations for class participation and homework completion until symptoms have cleared and neurocognitive function has returned to normal.

A MODEL FOR MANAGEMENT OF THE STUDENT-ATHLETE WITH A CONCUSSION

It is well within the reach of schools today to implement comprehensive programs to manage concussion injuries. Such programs can be designed to deal with both athletic and educational concerns while helping to ensure safety in competition and proper support for an injured student-athlete pursuing academic work during recovery (Figure). A comprehensive approach should include the following steps.

1. Concussion Education

In addition to athletes, coaches, and parents, school personnel (eg, guidance counselors, school nurses, teachers, social workers, and psychologists) should receive education during the school year so that they can be prepared for their roles in supporting student-athletes recovering from these injuries.

2. Preseason Baseline Testing

Baseline individual computerized neurocognitive testing, such as that offered by Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT, Pittsburgh, PA),⁴ HeadMinder (HeadMinder, Inc, New York, NY),⁵ CogSport (CogState Ltd, Melbourne, Australia),⁶ and Automated

Neuropsychological Assessment Metrics (ANAM, Defense and Veterans Brain Injury Center, Washington, DC),⁷ provides a preinjury measurement of the cognitive abilities that may be disturbed by concussion. Such testing controls for the effects of medications, learning disabilities, attention deficit/hyperactivity disorder (ADHD), and other preexisting conditions and can be conducted along with brief preseason educational meetings.

3. Postinjury Testing: Sideline Assessment and Neurocognitive Evaluation

In the event of a possible concussion, the AT immediately assesses the athlete for the presence and severity of concussion symptoms. A simple formalized protocol, such as the Standardized Assessment of Concussion²⁷ or Sports Concussion Assessment Tool,¹⁰ takes only minutes and includes provocative exertional testing to see if running or other sport maneuvers cause recurrent symptoms in an athlete who seems to have fully recovered while resting on the sideline.

The neurocognitive evaluation protocol involves initial testing within the first few days postinjury. If the athlete has not undergone baseline testing, return to expected performance levels is based on normative scores for age and sex and consideration of factors such as a learning disability, ADHD, or other preexisting condition, as well as the student-athlete's general level of academic achievement. Consultation with a clinical neuropsychologist is particularly important in making such clinical judgments. Periodic retesting tracks resolution of the athlete's subjective symptoms and improvement in cognitive functioning,^{4-7,18,21} providing useful information to school staff regarding the need for accommodations. Feedback to the student-athlete and parents regarding these results often helps them to better appreciate the extent of the initial symptoms and cognitive impairment and the presence of continuing difficulties during recovery. Once the athlete is fully symptom free and has regained the expected level of cognitive functioning at rest, a 20-minute to 30-minute physical exertion test (including running, push-ups, sit-ups, and other sport-specific physical maneuvers) is supervised by the AT. When the athlete remains symptom free and maintains neurocognitive performance level after this exertion, the athlete's recovery is deemed complete.

4. Academic Support During Recovery

While recovery is being tracked for athletic purposes, the student-athlete is faced with the challenge of maintaining pace in the classroom. Postconcussion symptoms often interfere with a student-athlete's ability to do academic work, participate in the classroom setting, and function interpersonally with peers and parents. Fatigue and sleep disruption may leave the student-athlete without the mental energy to participate in a full day of class work and evening studies. Cognitive deficits, which can exist even when student-athletes claim they are symptom free,²⁴⁻²⁶ may further undermine school participation.

The key issue is that the student-athlete will, in general, recover more quickly with rest, not only from physical exertion and athletic activity but also from the cognitive demands of academic work.²⁸ For the student whose

postconcussion symptoms last only a few days, this situation may not be much different than being out sick with a bad cold, the flu, or other short-term illness. When symptoms are more intense and persist for weeks, however, the student-athlete cannot so easily make up work by putting in extra time and effort after school or at home because such activity may exacerbate symptoms. The coordinated efforts of teachers, the guidance counselor, the school nurse, and sometimes other school personnel, working in conjunction with the student, parents, and team and primary care physicians, may be needed to resolve the situation. The majority of students, other than those with the most extreme and long-lasting symptoms, are able to continue in their studies with some temporary accommodations. The goal is to support the recovering student in keeping up with academic demands in a way that does not overstress the cognitive functions and result in worsening symptoms. A careful balancing of rest with academic work and an individualized plan that prioritizes academic work and uses appropriate, temporary, evolving accommodations allows the student to progress as symptoms improve. The actual design and implementation of such a plan vary according to the student-athlete's symptoms and academic needs as well as the personnel within the school who can best assist the student.

5. Return-to-Play Decision

The decision about returning a student-athlete to contact sport activity after a concussion involves the team physician and AT, who must approve the resumption of team sport practice and game activity; the personal care physician, who has also monitored the athlete's medical status from the time of injury, clearing for return to play; the athlete's parents, who must understand the possibly increased risk for further concussions^{2,29} with additional complications once an athlete has a history of concussion²; and the clinical neuropsychologist, who interprets test results, closely follows the student-athlete's postconcussive symptoms, and provides objective data about the level of recovery to key decision makers.

In the school setting, a written policy that clarifies the procedures for evaluation and medical clearance and delineates the roles of the professionals involved helps greatly in regulating this important process. Such a policy is often particularly useful to the AT, who is at the center of the evaluation and clearance processes. The policy should cover both athletic participation and guidelines for academic accommodation during recovery. The following section outlines appropriate accommodations for student-athletes recovering from concussions and the rationale for each accommodation.

REASONABLE ACCOMMODATIONS FOR STUDENTS IN RECOVERY

1. Excused Absence from Classes

The student-athlete's need to rest must be balanced with the academic work to be done (Table 1). For the student with intense symptoms, a few days of complete rest may be needed immediately postinjury. Then partial attendance might involve priority attendance at core classes, missing early classes and arriving at school later in the morning for

Table 1. Reasonable Accommodations for the Student-Athlete Recovering From Concussion

Accommodation	Rationale
Excused absence from class	Several days of complete rest, progressing to limited attendance, may be needed
Rest periods during the school day	When symptoms flare, brief rest and pain medication may allow student to return to class
Extension of assignment deadlines	Information-processing speed and ability to handle full workload may be impeded
Postponement or staggering of tests	Mental effort to prepare and then take test may worsen symptoms
Excuse from (or unweight) specific tests and assignments	Relieves emotional pressure and allows return to regular workload as soon as possible
Extended testing time	Information-processing speed may be impeded
Accommodation for light or noise sensitivity	Fluorescent light and high-stimulation environments may cause symptoms
Excuse from team sport practice and gym activities	No physical activity progresses to limited physical activity, as tolerated
Monitor backpack weight, stair use, playing of wind instruments	Avoidance of other physical exertion
Use of a reader (or recorded books) for assignments and testing	Lessens visual scanning and concentration demands
Use of a note taker or scribe	Lessens attentional, visual, and concentration demands
Use of a smaller, quieter examination room	Lessens stimulation and distraction
Preferential classroom seating	Lessens distraction
Temporary assistance of a tutor	Assists in organizing and prioritizing assignments

the student who is having sleep difficulty or morning symptoms, or leaving earlier in the afternoon for the student who becomes more symptomatic as the day goes on.

2. Rest Periods During the School Day

Many student-athletes are able to maximize class attendance if they can leave class when symptoms flare up in order to rest in the school nurse's office or other designated area. After half an hour or so of rest and possible use of over-the-counter pain medication, as directed by the physician, many students feel less symptomatic and are able to return to class.

3. Extension of Assignment Deadlines

Allowing extra time for the completion of homework assignments is an appropriate accommodation for student-athletes who are having difficulty with information processing and handling a full workload.

4. Postponement or Staggering of Tests

Taking tests while still symptomatic usually places the recovering student-athlete at a distinct and unfair disadvantage. Furthermore, even if the student is able to achieve passing grades, the mental effort needed to prepare for tests may exacerbate his or her symptoms. Postponing testing until the student-athlete is more fully recovered is therefore ideal. Particular care is necessary to avoid having recovering students take high-stakes tests, such as midterm or final examinations, high school Advanced Placement examinations, or SAT or ACT examinations. Some testing authorities allow students to disregard scores if they have not performed well, but other tests, such as the Advanced Placement examinations, cannot be retaken. During midterm or final examinations, when testing is clustered and more intensive, students may be able to pace themselves by scheduling no more than one examination per day or by allowing extra time between examinations. Student-athletes who are injured in the spring and have disabling symptoms at the time of yearly final examinations sometimes do better to wait until later in the summer to complete coursework and examinations.

5. Excuse From Specific Tests and Assignments

For younger student-athletes, whose current coursework does not have direct ramifications for college entrance or credit determinations, the most appropriate step may be to excuse them altogether from specific tests and assignments while they are symptomatic and to base their grades on homework and test scores achieved up to the time of injury. This may relieve student-athletes of emotional pressure during and immediately after recovery and allow them to return to the regular flow of their academic lives as soon as they are able. When a student continues with the usual work while symptomatic, another option is to assign less weight to test scores and grades earned during that time, as these are often below the student's usual level of capability.

6. Extended Testing Time

Because diminished information-processing speed is one of the most common postconcussive problems, extended time is frequently needed by student-athletes who are symptomatic but who feel well enough to attempt to continue with their scheduled examinations.

7. Accommodation for Oversensitivity to Light, Noise, or Both

Many student-athletes are unable to tolerate certain types or levels of light or noise while recovering. Fluorescent lighting can be particularly bothersome, as can high-stimulation environments, such as cafeterias and assembly halls. Turning down the lights in one area of a classroom or allowing the student to move away from the source of light or noise may help at times. Allowing the student to eat lunch away from the cafeteria or to skip an assembly should be considered. Permission to wear caps with visors or sunglasses in school can also be beneficial.

8. Excuse From Team Sport Practice and Gym Activities

Avoiding physical exertion is a priority in the early days of recovery, when that time is better spent resting or keeping up with class work. As recovery progresses, however, student-athletes often wish to continue attending

practices to be supportive of their team, to stay “in the flow” of team activities and game planning, and to show coaches and fellow athletes that they remain committed to the team. Such attendance is not a problem as long as obtaining needed rest and addressing academic work remain the priorities. Certain student-athletes need to be encouraged to attend only some of the team’s practice activities, skipping days or leaving early other days in order to complete homework or rest.

9. Avoidance of Other Physical Exertion

In addition to gym class, other activities that are part of the student-athlete’s regular school day can sometimes lead to physical overexertion. Because many students today are accustomed to carrying very heavy loads, backpack weight should be monitored. In schools with more stairs, students should be advised to take elevators, if available, or to climb longer sets of stairs very slowly. Furthermore, those who play wind instruments may find that the demands of breath control provoke symptoms, necessitating a break from playing or at least reduced participation in band activity.

10. Use of a Reader for Assignments and Testing

Many recovering student-athletes find that their symptoms are exacerbated by the visual scanning activity and concentration demands of reading. Thus, a reader for regular assignments or tests (or both) may lessen those information-processing demands. Another option is to use books on tape or CD or to tape record examination questions for the student to listen to at his or her own pace. If such testing accommodations are being considered, however, it may still be preferable to postpone examinations altogether.

11. Use of a Note Taker or Scribe

Because many recovering students have difficulty listening and taking notes at the same time in class, a note taker can lessen attentional demands and allow the student to focus on the lecture content. Similarly, as a result of the visual and concentration demands of writing, some students may more easily dictate homework essays, papers, and test answers.

12. Use of a Smaller, Quieter Examination Room to Reduce Stimulation and Distraction

During the recovery period, many student-athletes exhibit some of the same characteristics seen in individuals with ADHD, including vulnerability to distraction by routine sights and sounds that occur in examination rooms for larger classes. The opportunity to temporarily join smaller groups of students who regularly receive such accommodations for attentional disabilities during examinations or who are permitted to take examinations alone may therefore be very helpful.

13. Preferential Classroom Seating to Lessen Distraction

Students with attentional deficits tend to focus better when they are seated in front of the classroom or away from doors and windows. In classes with assigned seating,

the student-athlete may need to request a seat change. In other classes, the student-athlete should be encouraged to sit at the front of the room. Teachers should be prepared to facilitate such seating changes if a student seated in the back of the classroom seems to have trouble following discussions.

14. Temporary Assistance of a Tutor to Assist With Organizing and Prioritizing Homework Assignments

Student-athletes with concussion-related attentional deficits may have substantial problems organizing and planning their academic work. A brief daily meeting with the guidance counselor or an assigned tutor may help the student maintain academic priorities and keep track of scheduled assignments, quizzes, and tests. Furthermore, this assistance permits monitoring of the student’s ability to maintain pace and allows for timely identification of the need for additional accommodations if the student cannot keep up with the assigned work. When more severe symptoms result in an extended absence from school, tutoring may be best started at home to assist the student-athlete in regaining some academic momentum before returning to the challenge and stimulation of the regular school environment.

IMPLEMENTING AN ACCOMMODATION PLAN

The AT plays a leading and unique role in the process of concussion management, usually being the first among school staff to identify that a concussion has occurred. He or she is also centrally involved in every step, from preseason education through the return-to-play decision. As soon as the AT identifies a concussion injury, notice should be given to key members of the school staff, including the school nurse, guidance counselor, and student-athlete’s teachers in addition to the parents and team physician. This can be done easily through an e-mail sent out from the athletic department. This notice will indicate that the student-athlete has experienced a concussion, provide some relevant details, and remind the staff that the student may temporarily need assistance, as described above, with managing symptoms and academic demands. Once school personnel are accustomed to dealing with concussion recovery issues, this notice will quickly set in motion a valuable support system for the recovering student-athlete.

At times, the AT may not be the first to know about a concussion if it was not observed in school athletic activity, was not reported by the student, or occurred outside of school sports. In such cases, news of a concussion should still be communicated among the parties listed above by those who are the first to learn of the injury. In either event, active ongoing communication between the AT and his or her school colleagues regarding a student’s evolving symptoms, neurocognitive test scores, and general clinical presentation will serve to keep all members of the student’s larger school staff abreast of the student’s status and reminded of the key issues involved in proper concussion management. Ongoing e-mail communication among this group can serve to keep everyone informed of developments during recovery.

Student-athletes recovering from concussions may be more cooperative with recovery recommendations when

Table 2. Sources of Professional Support for the Concussed Student-Athlete

Professional	Contribution(s)
School nurse	Provides daily medical evaluations, rest and recovery area; communicates with athletic trainer
Guidance counselor	Coordinates academic accommodation
Social worker	Provides emotional support
School psychologist	Offers recommendations regarding workload and accommodations

they receive a consistent message from their athletic staff, academic faculty, parents, and health care professionals. Student-athletes should be reminded that achieving full recovery is crucial before returning to sport activity and that school personnel will work with them to accommodate their academic needs during recovery. It is very important to support student-athletes in being honest about any persisting symptoms and to help them understand that accepting the short-term loss of playing time is a wiser choice than risking the exacerbation of their symptoms, sustaining another concussion,^{2,30} or the possibility of an even more catastrophic injury, such as second-impact syndrome,^{1,19,20} caused by returning to play prematurely. This message helps student-athletes maintain appropriate priorities for their health, academic success, and sport participation.

Within the school setting, other professionals can play important roles in supporting the recovering student-athlete (Table 2). Although staffing, resources, and responsibilities vary from school to school, and although not all of these staff members will be involved in every student-athlete's postinjury management, a review of the distinct contributions that can be made by each of these specialists is worthwhile.

The *school nurse* carries out daily medical evaluations and provides a rest and recovery area when the student-athlete becomes more symptomatic during the school day. The nurse's record of daily contacts and symptoms offers a valuable method for tracking the student-athlete's progress and also helps to identify worsening symptoms, which may indicate the need to temporarily reduce the student's academic demands or school attendance to facilitate recovery. Nurses may find it very useful to review a checklist of typical postconcussion symptoms^{4,8,9} with the student-athlete during each visit because some students, particularly while they are experiencing physical discomfort or the cognitive effects of the injury, may not mention the full range of symptoms they are having. The school nurse should also be sure to communicate periodically with the AT about the student-athlete's recovery and to compare symptom reports. This information will be useful in helping the AT to determine the student's readiness to return to athletic activity. In some schools, the nurse may work with the AT to administer neurocognitive testing during recovery.

The student-athlete's *guidance counselor* typically coordinates the academic accommodation process and checks on the athlete daily for needed accommodation adjustments. Some schools will choose to write a 504 plan (which outlines accommodations related to a medical or other disability) for the recovering student-athlete that specifies appropriate accommodations related to the student's mild

traumatic brain injury. Although justified, a 504 plan may not be a priority if the school staff can mobilize to effectively implement the needed temporary accommodations. If a neuropsychologist or school psychologist is consulting on the student-athlete's concussion injury, his or her input should be sought in developing these accommodations.

Student-athletes in the recovery process may find it very stressful attempting to keep up with academic demands while not feeling well physically or cognitively. They are also prone to emotional changes and reactions, including feelings of irritability, anxiety, sadness, and depression, particularly during more prolonged recoveries. Some student-athletes are very upset about being held out of athletic activity. Others may actually be relieved to have a respite from their contact sport and might even appreciate support for not returning to the sport after their recovery is complete. The school *social worker* can play a valuable role in helping to support the student-athlete emotionally through this process. An information-oriented approach to such counseling reassures the student-athlete that the recovery process may be difficult at times, with better and worse days, but it is understandable and will have an end point. The emotional changes seen in the student-athlete at this time may also affect peer and family relationships, and the social worker can play a crucial role in helping to navigate these temporary disruptions. In addition, the social worker can maintain communication with the student-athlete's parents during this process and determine if the student is indeed receiving consistent understanding and support from family, friends, and school personnel.

For a student-athlete who was diagnosed with learning or attentional problems before a concussion, the *school psychologist* may offer particular insight into the ways in which postconcussive problems can further complicate learning difficulties and may be able to make specific recommendations regarding workload and accommodations. The school psychologist can also provide short-term counseling through the recovery period, as needed, and can work in tandem with the AT and consulting neuropsychologist both to implement baseline neurocognitive testing and to assure that follow-up testing is being completed on schedule for recovering student-athletes.

ADDITIONAL CONSIDERATIONS

Most sport-related concussions involve only a few days or weeks of symptoms followed by full recovery. There are, however, patients in whom symptoms are prolonged for weeks or months.³¹ Athletes with a history of concussion may be at higher risk for further concussions in sport and may have more prolonged symptoms with each subsequent injury. In more severe cases, the student-athlete may have to drop classes or even an entire semester of studies if all attempts at accommodation fail and if disabling symptoms continue even with minimal academic effort.

The neuropsychological assessment typically used in sport concussion injuries involves a brief and focused battery of testing designed to screen for anticipated changes in cognitive efficiency. Sometimes student-athletes who have not had baseline testing seem to return to the point of being symptom free and to their prior level of school functioning, but they do not achieve the levels of neurocognitive test performance expected for their age and

sex. On occasion, this may point to the possibility of a preexisting, undiagnosed learning disability or attention deficit disorder. For these students, further testing by the school in the form of a core evaluation or a more in-depth neuropsychological assessment may be indicated to rule out these conditions. Student-athletes with a history of multiple concussions may show lingering cognitive deficits on postconcussion testing and persisting performance deficits in their schoolwork that are consistent with long-term cognitive disabilities. More comprehensive educational and neuropsychological evaluation may, therefore, be indicated if recovery has not occurred by approximately 3 months postinjury. Fortunately, such instances are uncommon, and the patient may still continue to slowly improve over time, but more comprehensive testing can be useful to better understand the student-athlete's full range of cognitive strengths and weaknesses. Such testing can then become the basis for more detailed academic planning and accommodations.

ACKNOWLEDGMENTS

I thank Robert Burke, ATC, and Jerry Ciffone, MSW, for their review of earlier versions of this article and Wayne M. Dinn for his invaluable assistance in the preparation of the manuscript.

REFERENCES

1. Cantu RC. Recurrent athletic head injury: risks and when to retire. *Clin Sports Med.* 2003;22(3):593–603.
2. Guskiewicz KM, McCrea M, Marshall SW, et al. Cumulative effects associated with recurrent concussion in collegiate football players: the NCAA Concussion Study. *JAMA.* 2003;290(19):2549–2555.
3. Iverson GL, Gaetz M, Lovell MR, Collins MW. Cumulative effects of concussion in amateur athletes. *Brain Inj.* 2004;18(5):433–443.
4. Lovell MR. The ImpACT neuropsychological test battery. In: Echemendia RJ, ed. *Sports Neuropsychology: Assessment and Management of Traumatic Brain Injury.* New York, NY: Guilford Press; 2006:193–215.
5. Kaushik T, Erlanger DM. The HeadMinder Concussion Resolution Index. In: Echemendia RJ, ed. *Sports Neuropsychology: Assessment and Management of Traumatic Brain Injury.* New York, NY: Guilford Press; 2006:216–239.
6. Collie A, Maruff P, Darby D, Makdissi M, McCrory P, McStephen M. CogSport. In: Echemendia RJ, ed. *Sports Neuropsychology: Assessment and Management of Traumatic Brain Injury.* New York, NY: Guilford Press; 2006:240–262.
7. Bleiberg J, Cernich A, Reeves D. Sports concussion applications of the Automated Neuropsychological Assessment Metrics Sports Medicine Battery. In: Echemendia RJ, ed. *Sports Neuropsychology: Assessment and Management of Traumatic Brain Injury.* New York, NY: Guilford Press; 2006:263–283.
8. Aubry M, Cantu R, Dvorak J, et al. Summary and agreement statement of the First International Conference on Concussion in Sport, Vienna 2001: recommendations for the improvement of safety and health of athletes who may suffer concussive injuries. *Br J Sports Med.* 2002;36(1):6–10.
9. Guskiewicz KM, Bruce SL, Cantu RC, et al. National Athletic Trainers' Association position statement: management of sport-related concussion. *J Athl Train.* 2004;39(3):280–297.
10. McCrory P, Johnston K, Meeuwisse W, et al. Summary and agreement statement of the 2nd International Conference on

- Concussion in Sport, Prague 2004. *Br J Sports Med.* 2005;39(4):196–204.
11. Cantu RC, Aubry M, Dvorak J, et al. Overview of concussion consensus statements since 2000. *Neurosurg Focus.* 2006;21(4):E3.
12. McCrory P, Meeuwisse W, Johnston K, et al. Consensus statement on concussion in sport: The 3rd International Conference on Concussion in Sport, held in Zurich, November 2008. *J Clin Neurosci.* 2009;16(6):755–763.
13. Gessel LM, Fields SK, Collins CL, Dick RW, Comstock RD. Concussions among United States high school and collegiate athletes. *J Athl Train.* 2007;42(4):495–503.
14. McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz KM. Unreported concussion in high school football players: implications for prevention. *Clin J Sport Med.* 2004;14(4):13–17.
15. Guskiewicz KM, Weaver NL, Padua DA, Garrett WE Jr. Epidemiology of concussion in collegiate and high school football players. *Am J Sports Med.* 2000;28(5):643–650.
16. Webbe FM. Definition, physiology, and severity of cerebral concussion. In: Echemendia RJ, ed. *Sports Neuropsychology: Assessment and Management of Traumatic Brain Injury.* New York, NY: Guilford Press; 2006:45–70.
17. Collins MW, Iverson GL, Lovell MR, McKeag DB, Norwig J, Maroon J. On-field predictors of neuropsychological and symptom deficit following sports-related concussion. *Clin J Sport Med.* 2003;13(4):222–229.
18. Reddy CC, Collins MW, Gioia GA. Adolescent sports concussion. *Phys Med Rehabil Clin N Am.* 2008;19(2):247–269.
19. Cantu RC, Voy R. Second-impact syndrome: a risk in any contact sport. *Physician Sports Med.* 1995;23(6):27–34.
20. Cantu RC. Second-impact syndrome. *Clin Sports Med.* 1998;17(1):37–44.
21. Iverson GL, Brooks BL, Collins MW, Lovell MR. Tracking neuropsychological recovery following concussion in sport. *Brain Inj.* 2006;20(3):245–252.
22. Ellemberg D, Leclerc S, Couture S, Daigle C. Prolonged neuropsychological impairments following a first concussion in female university soccer athletes. *Clin J Sport Med.* 2007;17(5):369–374.
23. Sim A, Terryberry-Spohr L, Wilson KR. Prolonged recovery of memory functioning after mild traumatic brain injury in adolescent athletes. *J Neurosurg.* 2008;108(3):511–516.
24. Broglio SP, Macciocchi SN, Ferrara MS. Neurocognitive performance of concussed athletes when symptom free. *J Athl Train.* 2007;42(4):504–508.
25. Fazio VC, Lovell MR, Pardini JE, Collins MW. The relation between post concussion symptoms and neurocognitive performance in concussed athletes. *NeuroRehabilitation.* 2007;22(3):207–216.
26. Lovell MR, Collins MW, Iverson GL, Johnston KM, Bradley JP. Grade 1 or “ding” concussions in high school athletes. *Am J Sports Med.* 2004;32(1):47–54.
27. McCrea M, Kelly JP, Randolph C, et al. Standardized Assessment of Concussion (SAC): on-site mental status evaluation of the athlete. *J Head Trauma Rehabil.* 1998;13(2):27–35.
28. Mayers L. Return-to-play criteria after athletic concussion: a need for revision. *Arch Neurol.* 2008;65(9):1158–1161.
29. Zemper ED. Two-year prospective study of relative risk of a second cerebral concussion. *Am J Phys Med Rehabil.* 2003;82(9):653–659.
30. Gerberich SG, Priest JD, Boen JR, Straub CP, Maxwell RE. Concussion incidences and severity in secondary school varsity football players. *Am J Public Health.* 1983;73(12):1370–1375.
31. Collins M, Lovell MR, Iverson GL, Ide T, Maroon J. Examining concussion rates and return to play in high school football players wearing newer helmet technology: a three-year prospective cohort study. *Neurosurgery.* 2006;58(2):275–286.

Address correspondence to Neal McGrath, PhD, Sports Concussion New England, 1368 Beacon Street, Suite 116, Brookline, MA 02446. Address e-mail to dr.neal@sportsconcussion.net.