Editor's Note:

The 4th International Conference on Concussion in Sport was held in Zurich, Switzerland, in November 2012. Bringing together an international panel of experts in the areas of neurology, psychology, sports medicine, rehabilitation, and kinesiology, the group released a Consensus Statement on Concussion in Sport in March 2013, which updates the previous 2008 statement. The document joins a number of other recently released guidelines including new guidelines on the evaluation and management of sports concussion released by the American Academy of Neurology (AAN) the same month. The American Medical Society for Sports Medicine Position Statement, Concussion in Sport, was released in January 2013. Another consensus statement on concussion, focusing on the role of the team physician and developed jointly by the American Academy of Family Physicians, the American Academy of Orthopaedic Surgeons, the American College of Sports Medicine, the American Medical Society for Sports Medicine, the American Orthopaedic Society for Sports Medicine, and the American Osteopathic Academy of Sports Medicine, dates from 2011. How does the clinician make sense of this plethora of recommendations? To try to answer this question, Medscape interviewed Allen Sills, MD, an author of the recent international consensus statement, Associate Professor of Neurological Surgery at Vanderbilt University, and a cofounder of the Vanderbilt Sports Concussion Center, to bring some clarity to the process of evaluating children and adults with concussion.

Concussion vs mTBI

Medscape: Could you begin by discussing the definition of concussion? The international consensus group makes a clear distinction between concussion and mild traumatic brain injury (mTBI), in contrast to other guidelines. What is the difference?

Dr. Sills: Concussion is a transient trauma-induced alteration in brain function, meaning that there is a start and stop time to the symptoms and that it is obviously associated with some discrete traumatic event with an alteration of brain function that can be manifested by many different symptoms. The term mTBI is much broader because it refers to a whole spectrum of injuries to the brain that can occur as a result of trauma, most of which are less likely to be sports-related, and it also encompasses a number of structural injuries to the brain that are associated with trauma. That is in contrast to a concussion, where traditional brain imaging is normal. Concussion is much more of a functional rather than a structural injury. The document implied, but did not state, that concussion involved negative imaging while mTBI involved positive findings on imaging.

Assessing the Athlete With Concussion

Medscape: The assessment of injured athletes, both on the sidelines and in the healthcare setting, is critical. Older subjective assessments, such as standard orientation questions (eg, time, place, and person), are recognized to lack sufficient sensitivity and specificity, particularly shortly after a head injury when the athlete’s symptoms may be evolving. All guidelines emphasize use of standardized tools. The international consensus statement specifies 3 in particular: the Sport Concussion Assessment Tool -- 3rd edition (SCAT3™), Sport Concussion Assessment Tool for children ages 5 to 12 years (Child SCAT3™), and the Concussion Recognition Tool™ (CRT), which is designed for lay use. Can you discuss the advantages of these tools? Are they sufficient alone in making the diagnosis of concussion, or is a combination of diagnostic tests needed?
Dr. Sills: I like to talk about concussion evaluation as a 360-degree evaluation, meaning that you want to use these types of assessment tools along with your clinical observation; your knowledge of the athlete; their previous history, experience, and symptoms; and your own diagnostic and clinical experience to reach this diagnosis. The consensus authors are trying to get away from saying that any one tool is the absolute gold standard or is going to be sufficient in 100% of cases. These are simply tools designed to standardize the concussion assessment from one practitioner to another and also to take into account the differences in resources that may be available in different countries and different competition situations.

The components of the tools have been vetted extensively, and included items are those that have been found to be the most useful with good predictive value in detecting concussions. We want something that has a high positive predictive value so that we are not missing injuries and allowing athletes to continue to play when they, in fact, have been injured. That is the philosophy behind those particular tools. It is true that they have not been validated across all ages and patient populations, but our wealth of clinical experience along with validation of certain components would suggest that they are very useful for the purpose for which they are designed.

The CRT is an acknowledgement that many and, in fact, most times there is not a trained healthcare provider at youth sporting events. One of the important perspectives to keep in mind is that the international Concussion in Sport Group works to think about this problem on a global basis and thus develop guidelines and tools that can be applied in a variety of countries and with a variety of different resources and availability of trained personnel.

We often think of concussion as being a problem in American football; in reality, that is a very small part of the athletic-related concussions that occur on a worldwide basis. Our meeting to develop these guidelines was held in Switzerland at the home of Fédération Internationale de Football Association (FIFA), the worldwide soccer organization, and several of the physician leaders from FIFA were quick and frequent to point out that, at most, American football had several million participants; as opposed to soccer, which boasts nearly 400 million participants worldwide.

These numbers provide a sense of the global scope of these problems, and that is the spirit and intent with which these guidelines were developed. Based upon what we know in the United States, for example, there are many schools that do not have an athletic trainer. Beyond that, there are many youth sports leagues that are not school-based that do not have trained athletic personnel present. The idea behind the CRT is to provide a simple tool that nonmedical personnel can use in order to do a preliminary screen to determine if a concussion may have occurred. We do not expect that these individuals would assume expert management of the injury. We are simply trying to increase recognition that the injury may have occurred and, if there is any suggestion that a concussion may have occurred, to remove that athlete from the competition and have them evaluated by a healthcare professional.

The CRT could be used by coaches, parents, teachers, or other bystanders. I liken it somewhat to the advent of basic CPR (cardiopulmonary resuscitation) or AED (automatic external defibrillator) use. The idea behind placing defibrillators in shopping malls and airports is not that they are going to be available for doctors and nurses who happen to be on scene but rather so that the lay public can use them in an emergency.

Medscape: Neuropsychological (NP) testing is increasingly recognized as contributing significant information to the evaluation of individuals with suspected concussion as well as management decisions such as return to play (RTP). What approaches to NP testing are recommended by the consensus group? Does testing require referral to a psychologist/psychiatrist/therapist?

Dr. Sills: I think one of the ideas behind the importance of NP testing is the unfortunate reality that athletes are not always truthful with us in reporting their symptoms. Much of the diagnosis of concussion relies upon self-reported symptoms such as headache, dizziness, fogginess, or sensitivity to noise or light. These are all symptoms patients in any medical setting complain about rather than signs that we can objectively measure and observe. Given that inherent difficulty, it is helpful to have an objective measure of brain function to help us make the diagnosis of
concussion. NP testing for sports concussion assesses areas of brain function such as verbal and visual memory, information retrieval, reaction time, and processing speed; all of these are parameters that may be adversely affected by a concussion. If we have a way to measure those functions objectively, we may then be able to detect a brain injury even if the athlete is not being truthful in reporting symptoms.

To extend that further, it is most helpful if we have a baseline test that allows us to see a particular patient's normal score in those areas and then compare that after injury. That is going to give us the best idea of whether there has been a significant change. That is why NP testing has come into favor -- it is one more way to assess for a potential concussion and to monitor recovery from a concussion. At the same time, one has to be careful with the data and make sure that you understand its limitations because, again, it is not a gold standard, stand-alone test that allows the clinician to ignore all other tests and all other assessments and simply assume this test is going to tell us whether or not a concussion is present. You are simply gathering information in much the same way that you do in other diagnoses in medicine. Further, the NP testing used in sports concussion assessment is a screening test and is not the same as a more traditional, comprehensive NP assessment. For example, if a patient presents with fever, reports a productive cough, and they have an infiltrate on their chest x-ray, you have now built the case that they indeed may have pneumonia. That is a much more powerful diagnosis than if we simply had only 1 piece of information and tried to diagnose every patient that came in the office with a cough as having pneumonia. We are obviously not going to be nearly as accurate.

In terms of who should be performing baseline testing, we know now that baseline testing has to be conducted in a controlled and monitored environment where we ensure that the athlete is giving his or her best performance and we are providing an appropriate testing environment. There are 2 different basic ways in which NP testing is done. One is the pencil-and-paper test, which has been around for many years. The new versions are the computerized NP tests, which have become quite popular. I think that in both of those instances, you want someone administering the test that has been trained and certified to understand the issues that go along with conducting an accurate test because having a bad baseline is probably worse than having no baseline. In more complicated instances (eg, an athlete with attention-deficit/hyperactivity disorder, learning disability, or other modifying factors), it might be ideal to have input from a neuropsychologist.

Management: Can This Athlete Return to Play?

Medscape: The international consensus statement unequivocally says that no athlete with a suspected concussion should be allowed to RTP on the same day. While the AAN guideline is not as prescriptive, it also clearly notes that RTP should not occur until the player has been evaluated by a healthcare professional and is asymptomatic. The AAN also suggests that graded physical activity plans may be necessary though does not describe an RTP protocol such as that offered in the international consensus statement. Can you discuss RTP guidelines including the role of graduated RTP protocols?

Dr. Sills: The biggest issue with RTP is that we want to make sure that the injury has completely healed before we put the athlete at risk of suffering another blow to the head. Once again, we are relying on a multimodality assessment to ensure that the injury has completely healed. That includes a normal clinical neurologic examination, the patient's self-report of no symptoms, a return to normal school and work performance, and an ability to perform through a normal day. It should also include normal baseline balance. If brain imaging has been done, it should be normal. Additionally, we will put the athlete through progressive increases in physical exertion to see if we elicit any symptoms. We want to also make sure that the NP assessment is back to the athlete's baseline or is in what we could consider to be a normal range.

This is a place where our practice has changed over the past 10-15 years. For example, we used to test the athlete and perform NP testing immediately after the injury, and we saw that these tests were very sensitive in detecting changes in performance as a result of the injury. Day 2 after the injury, we would bring the athlete in, find that he or she was still having a host of symptoms and repeat the NP testing, and, sure enough, their performance was down.
Over time, we have gotten away from testing during that stage because testing done in the immediate injury period, while the athlete is still symptomatic, does not change our management. In other words, as long as the athlete is still reporting symptoms, we should not even think of returning them to activity. Therefore, performing NP testing at that point does not change our management. In fact, doing the test while the athlete is having symptoms can actually increase the symptoms in many cases because we are putting more metabolic demands on the brain just by doing the testing. We have gotten away from doing those immediate postinjury tests. Now most practitioners will wait until the athlete says that he or she is asymptomatic at rest or, sometimes, with mild exertion before doing follow-up NP testing. What you are attempting to determine with that postinjury test is that performance is back to normal.

RTP protocols are the result of the recognition of the need for the athlete to engage in progressive exertion with more activity day by day to see if it elicits an emergence of symptoms because there are individuals who will have no symptoms as long as they are at rest and not getting their heart rate or blood pressure up with exertion. However, once they start to exert themselves, their symptoms will return. Therefore, we want to put the athletes through a progressive RTP with increasing amounts of activity to make sure that we don't miss the athlete with no symptoms at rest whose symptoms return with exertion.

The usual timing for progression through an RTP protocol is a minimum of 1 day between levels and often is age-dependent, as greater caution is warranted with younger athletes. For athletes who experience a return of symptoms at any given level, we will typically have them wait for 24 hours and then go back down 1 step and resume the protocol again to see if symptoms emerge. An athlete who has no symptoms at rest but a re-emergence of symptoms during one of the steps is just not quite ready to progress and needs a little bit more time though they are fairly close in terms of their recovery at that point.

I think one important point to emphasize is the idea that, before starting a return to exertion protocol, the athlete, and particularly the school-aged child, needs to be able to have cognitive exertion with no symptoms. We are strong advocates for the position that if a child cannot attend a full school day with normal workload with no symptoms, then that child should not be undertaking an exertion-based RTP protocol. If the child is having symptoms from cognitive exertion, not physical, but just cognitive exertion, then that is telling us that the brain is still not healed enough to return them to play. We emphasize return to learn before RTP. That is not true only in young children; that's also true in our college-aged athletes as well. For postcollege athletes, the principle is the same.

Medscape: While the majority of concussions resolve in 7-10 days, with a somewhat longer recovery time typical in children and adolescents, there are individuals who will suffer prolonged symptoms. The international consensus statement notes concussion modifiers that may predict the potential for persistent symptoms. Equally the document notes some factors that do not appear to correlate with prolonged symptoms. Can you describe these factors?

Dr. Sills: The large majority, 85%-90%, of concussions will resolve completely in 30 days or fewer, and the athlete will be ready for full RTP. However, this means there are 10%-15% that do not. We are learning that this group behaves very differently and follows a very different trajectory of recovery from the other group. Whether that reflects a different underlying pathophysiology or a different genetic susceptibility or more likely a combination of the two is unclear and is an area of very active study. The idea behind the concept of concussion modifiers is that there are some features that could be identified prospectively that might predict a person to be in one group or the other.

The biggest implication that came from this set of recommendations is that these athletes who experience a different trajectory of recovery will need a different care plan as well. In particular, some of the methods used in the short-term group may not be applicable. For example, we tend to withhold athletes from school and from all types of cognitive activity and stimulation in the first few days after injury because it is thought that activities will aggravate the injury, and we want the injury and symptoms to get better; and, in fact, that approach tends to be fairly useful. On the other hand, once athletes reach the 30-day mark, simply continuing to avoid all cognitive exertion may very
well be counterproductive. What we see happening is that many times these athletes will become socially, emotionally, and academically isolated to an extent that probably hinders their recovery.

If you think about it, many of these students have a large part of their identity that is defined through their athletics and participation in a team sport. Now, all of a sudden, we have taken that away from them, and they are no longer able to participate with their teammates and friends. They cannot attend practice or games, and we take them completely out of school, they are getting behind in all of their classes, and we do not allow any social activities. Pretty soon, we have created a caveman that sets the athlete up for a whole host of other problems that can develop simply from isolation alone. The take-home message for practitioners from the document and from our own clinical experience is: If you have an athlete who is having symptoms for more than 30 days, that athlete really needs a complex, multidisciplinary assessment of the type that is most likely to be performed at a concussion center. That care must take into account a number of other factors and not only manage the symptoms but explore some of the physiological, psychosocial, and pathologic changes found in this group.

Preparticipation Evaluation

**Medscape:** Can we switch gears and talk about preinjury assessment and, in particular, the concussion history? What are key elements of this history? Are there factors that should alert clinicians to a potentially increased risk for concussion?

**Dr. Sills:** The most important element of the history is the number and type of any previously suffered injuries that were diagnosed as concussion or produced concussion-like symptoms. We need to know how many concussions an athlete has suffered, the symptoms and their duration, and their trajectory of recovery from previous concussions. Secondarily, it is helpful to know about history of other neurologic conditions such as seizures, developmental or learning disabilities, and a headache history that includes family headache history, including a history of migraine, headaches, and a history of other neurologic conditions in the family. Those are the really key elements of a good concussion history. The postinjury tools such as the SCAT3 can be useful for conducting baseline evaluations that include a baseline performance for an individual athlete.

**Medscape:** While the consensus statement recommends NP testing for all athletes, it stops short of requiring baseline NP testing as a mandatory part of the preparticipation evaluation of athletes. However, are there individuals who should receive baseline NP testing?

**Dr. Sills:** There are 2 considerations. One, again you have to understand the recommendations of the group were made in light of a global perspective. Baseline testing is simply not going to be available or affordable in many countries, and the group felt that mandating it would be an undue burden given our current state of knowledge. That being said, I think baseline testing is an important adjunct for us in an overall concussion management program, and it is not simply the baseline NP testing. For example, in our clinical practice at our concussion center and throughout all of the schools and youth leagues that we work with, we like to have not only baseline NP testing on each athlete but we like to have a baseline balance assessment and a baseline neurologic history that includes a screen for history of headache disorders, learning disabilities, family history of headaches, and other conditions that have been shown to have some predictive value about the course after concussion.

A reasonable goal for schools and leagues that have ability to perform these evaluations would be that this testing is performed on every athlete who has the potential to sustain a head injury during the course of their sport. That obviously is going to include most of our school-based sports. It is a mistake to think this is a problem only in football or ice hockey, for example. We see an almost equivalent number of soccer players each fall as we do football players. We are also seeing athletes from a variety of sports, including wrestling, cheerleading, volleyball, basketball, baseball, rodeo, gymnastics, and diving. You name it. Any of these athletes are at risk for injury. It is, again, a question of resources. If a school or an organization has limited resources, certainly one would want to
obtain baseline testing in those sports with the highest rates of concussion. However, the ideal is to offer this to all athletes and give them all access to the best of care.

**Medscape: Are there specific resources you would recommend for clinicians, both on the field and in the primary care or emergency setting?**

**Dr. Sills:** The Centers for Disease Control and Prevention offers an excellent resource called the [Heads Up Tool Kit for Youth Sports](http://www.cdc.gov/ncbddd/concussion/headsup/index.html).

In terms of NP testing, [ImPACT® (Immediate Post-Concussion Assessment and Cognitive Testing)](http://www.impactsymptoms.com) is one of the more commonly used tools, and there are a number of resources on their Website that review published data concerning reliability and validity of the different modules of the ImPACT test and discuss how the testing can be used during concussion recovery.

This is an evolving area that takes a village. It is up to all of us in the medical community to try to educate ourselves and to make resources available in our individual communities. I encourage clinicians to reach out, not only within their office practice but at schools and at youth sports leagues in their communities, and get involved and help leagues to develop policies and education for their coaches and parents. Again, statistics show that a very small minority of these injuries occur when an athletic trainer or a physician is present. These injuries are occurring on fields of play where there are only parents and teachers and coaches. Even in a country as well-resourced as ours, we are never going to be able to have an athletic trainer or doctor at every one of these events. It is incumbent on all of us to not only educate ourselves as medical professionals but to get this information in the hands of youth sports leagues and school-based leagues and to encourage use of tools like the CRT to help these folks make a diagnosis. Recognition and awareness are the big keys, and if we can simply get leagues and coaches to be aware of what to look for and how to make these basic assessments, then we are going to provide an enormous service to athletes throughout our country at all levels of competition. That, to me, is one of the most important messages that can come from this.

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