Audiologists have a key position to play in managing athletes who sustain a concussion. Missing the diagnosis of concussion’s audiologic consequences may delay return to play, work, or other daily activities, as well as increase the risk of depression, sleep disturbances, anxiety, and change in mood or behavior, said Dana Day, AuD, managing member of Arizona Balance and Hearing Associates (ABHA) and an audiologist with Banner Concussion Center and the Central Arizona Center for Therapeutic and Imaging Services (CACTIS) Foundation, which is creating a concussion management program in Phoenix.

Unfortunately, awareness and understanding of the auditory and vestibular side effects of concussion, which can include benign paroxysmal positional vertigo, hearing loss, tinnitus, noise sensitivity, and auditory processing problems, is “still in its infancy,” Dr. Day said.

This information gap may not come as a surprise, given that data on sports-related concussions are lacking overall, especially in younger populations, as noted in the Institute of Medicine–National Research Council (IOM–NRC) report on Sports-Related Concussions in Youth: Improving the Science, Changing the Culture, released Oct. 30, 2013.

Approximately 1.6 million to 3.8 million “sports- and recreation-related traumatic brain injuries (TBIs), including concussions and other head injuries, occur in the United States each year,” the report authors noted, citing a 2006 article from the Journal of Head Trauma Rehabilitation (21[5]:375-378). However, because athletic concussions are likely underreported, these figures may be higher, they added.

Awareness of the issue has increased, though, and is partly behind a rise in the incidence of sports-related concussion over the past decade, according to the report. For example, the reported number of people age 19 and younger treated in U.S. emergency departments for concussions and other nonfatal, sports-, and recreation-related TBIs increased from 150,000 in 2001 to 250,000 in 2009.

Generally, concussions are more frequent among high school athletes than college athletes in football, men’s lacrosse and soccer, and baseball, according to the IOM–NRC report. Concussion is also more common during competition than practice, except when it comes to cheerleading.

Sports with the highest incidence of concussion include football, ice hockey, lacrosse, wrestling, soccer, and women’s basketball. Concussion rates also appear greater for youths with a history of concussions and among female athletes.

LESSONS FROM MILITARY RESEARCH

While data on the auditory side effects associated with sports-related concussion are limited, Dr. Day noted, audiologists can learn a lot from TBI research in military personnel.
Tinnitus and hearing loss are two of the most widely reported audiologic consequences of traumatic brain injury, said Paula Myers, PhD, chief of the Audiology Section at the James A. Haley Veterans’ Hospital in Tampa, FL, whose comments for this article are based on her research of injuries from blasts or motor vehicle accidents.

In a report on veterans of the Iraq and Afghanistan wars who were evaluated for traumatic brain injury, 59 percent experienced sensitivity to noise, and 66 percent reported hearing difficulty (Brain Injury 2012;26[10]:1177-1184). Another study of military personnel with TBI found that up to 38 percent complained of tinnitus (J Rehabil Res Dev 2007;44[7]:921-928).

“The audiologist must be able to adjust testing on the fly at times to get the diagnostic information needed.”

Following TBI, audiologic sequelae may arise from debris, tears, or external bleeding in the ear canal; a ruptured tympanic membrane or ossicular damage in the middle ear; cochlear damage with or without eighth nerve complex injury; disruption of the membranous labyrinth; or vascular compromise in the inner ear, Dr. Myers said. The temporal bones and central auditory nervous system pathways may also be affected.

A standardized approach to audiological management of TBI patients does not exist because peripheral and central function; speech perception abilities in quiet and degraded conditions; cognition; and emotional, behavioral, and physical health all vary greatly in this population, Dr. Myers said.

However, audiological assessment of mild TBI should begin with a comprehensive case history that includes pre- and post-injury information about physical and cognitive functioning, visual ability, dizziness, and hearing, including tinnitus and exposures to loud noise, she recommended.

Information gathering about traumatic brain injury should focus on the nature of the injury, use of protective gear, loss of consciousness at the time of injury, history of prior head injuries, and current medications, she said.

Patients with mild TBI should then receive an audiolologic evaluation with otoscopy, pure-tone audiometric thresholds up to 12,000 Hz or the frequency limits of the individual’s hearing, speech recognition testing in quiet and in noise, a complete immittance battery, otoacoustic emission testing, evaluation for central auditory processing disorders, and electrophysiological evaluation with appropriate referrals to otolaryngology, Dr. Myers said.

Reassessing patients with TBI six months post-injury and annually thereafter—sooner if subjective changes are noted—is advisable due to the potential for latent sequelae, she added.

INVISIBLE INJURIES

One of the greatest challenges for audiologists addressing sports-related concussion is that both audiological problems and brain injuries are not readily visible, Dr. Myers said.

Another difficulty is that auditory symptoms are only one of many sensory problems seen in these patients, Dr. Day said. Testing in a well-lighted room may not be possible due to light sensitivity. Additionally, the optokinetic stimulus itself may induce motion intolerance.

“The audiologist must be able to adjust testing on the fly at times to get the diagnostic information needed,” Dr. Day said.

Lack of awareness is another obstacle to care, she added. While audiologists know mild TBI can cause ossicular bone dislocation, they’re not as familiar with the cognitive and oculomotor aspects of concussion. Consequently, they may assume patients are “not giving their best effort” during diagnosis.

In her clinic, Dr. Day most often sees the audiologic sequelae of tinnitus, noise sensitivity, hearing loss, and auditory processing difficulties.

“These complaints are likely explained by damage to the outer hair cells of the cochlea, damage to the ossicular chain, cognitive deficits in the speed at which auditory information is processed, attention to auditory information, and memory,” she said.

Dr. Day also commonly sees dizziness, vertigo, headaches, and sensitivity to light in her patients.

To provide the best possible evaluation and management of sport-related concussion, audiologists should work with a multidisciplinary team, she said.

This approach is especially useful in patients who continue to experience symptoms beyond a three-month follow-up period. Some individuals “do not get better on rest alone,” she said.

MULTIDISCIPLINARY APPROACH

At Banner Concussion Center and the CACTIS Foundation, the multidisciplinary team includes a physician trained in sports-related injuries and concussions; neuropsychologists familiar with neurocognitive testing; professionals experienced in comprehensive neurovestibular assessment and therapy; providers of vision services, including optometric evaluation and treatment; and audiologists who conduct a comprehensive evaluation.

Protocols for working with concussion patients at Arizona Balance and Hearing Associates involve a complete medical history and the performance of tests for high-frequency distortion-product otoacoustic emissions, ultrahigh-frequency (12,000 Hz to 20,000 Hz) hearing thresholds, ipsilateral and contralateral acoustic reflex thresholds, and speech in noise, which, if abnormal, may require full evaluation for a central auditory processing disorder.
The center also conducts videonystagmography (VNG), with a well-defined protocol for ocular motor testing. “Our clinic prefers to utilize water caloriccs whenever possible to assure the most accurate caloric findings,” Dr. Day said.

She and her colleagues may consider other tests such as ice water caloriccs, rotary chair testing, computer dynamic posturography, and cervical vestibular-evoked myogenic potential with or without ocular vestibular-evoked myogenic potential.

Video head impulse testing is still being evaluated by the practice for use in patients with a concussion.

“I believe [its] greatest value may come in testing the pediatric patient, but the final verdict is still out,” Dr. Day said.

GETTING A BASELINE
Arizona Balance and Hearing Associates is working with the CACTIS Foundation to offer baseline testing services to its youngest patients and athletes, who are 6 to 14 years old.

“We hope that by gathering this information prior to injury it will offer an objective measure for making the critical return-to-play decision,” Dr. Day said.

At a minimum, an audiogram and VNG need to be conducted to assure a baseline measurement in case tinnitus or dizziness present as late-onset symptoms, meaning three to six months after injury, Dr. Day said.

In addition to testing, audiologists at Arizona Balance and Hearing Associates directly manage several concussion-related sequelae, such as sensorineural and conductive hearing loss and benign paroxysmal positional vertigo, Dr. Day said.

Tinnitus can be the most challenging condition to address because therapy must be personalized to the patient, she said.

Appropriate medical and psychological referrals should be made for tinnitus, Dr. Myers added.

Sudden-onset tinnitus, with or without hearing loss, requires same-day assessment by otolaryngology and audiology, she said. If the condition is causing severe distress or challenges with coping, referrals should also include psychology.

COLLEGE-LEVEL CONCUSSION MANAGEMENT
To provide better care for its student athletes with potential concussion, Lamar University in Beaumont, TX, implemented a program in the fall of 2013 that uses cognitive and vestibular tests to assess students.

“Usually a concussion will show up as a cognitive problem or a balance problem,” said program developer Vickie B. Dionne, AuD, who is also associate professor and program director of audiology at the university.

“We’re worried about the player who comes off the field and says he was hit hard and then, the next day, has a headache, or everything is blurry, or he can’t process what you say. These symptoms don’t show up right away.”

Currently, the Balance Error Scoring System (BESS) is widely used to assess balance deficits indicating concussion, Dr. Dionne said. It requires a trainer to subjectively evaluate a variety of the athlete’s stances to see if the body sways.

“This is a test that a lot of teams are using from middle school up through college,” she said.

In addition to BESS, a pencil-and-paper test for cognition such as the Standardized Assessment of Concussion is commonly used.

“It consists of questions about the day, year, and the athlete’s name; immediate recall; concentration; and delayed recall,” Dr. Dionne said.

However, given that only three versions of the paper test are available and athletes have been taking the tests for years, subjects often have responses memorized. “It’s no longer a true test,” she said.

UPDATED TESTING
After a heavy overhaul of Lamar’s National Collegiate Athletic Association (NCAA) concussion management plan, Dr. Dionne and colleagues studied 400 student athletes using updated concussion assessment technology, including computerized dynamic posturography (CDP). CDP provides vestibular evaluation of concussion through the assessment of balance, postural sway, and weight bearing.

In addition, researchers used the computerized ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing). Since the test is randomly generated each time it’s given, athletes can’t memorize it, Dr. Dionne said.

She and coinvestigators acquired baseline CDP and ImPACT assessments from athletes before practice or play and then tested them after a head injury was sustained.

“We thought we were going to test athletes within 24 hours of concussion, but we found a lot of symptoms didn’t show up until 48 to 72 hours later,” she said.

Athletes were not allowed to play until both tests were back to baseline. “We benched quite a few players throughout the year for up to two to three weeks,” she said.

Most people recover from concussion within seven to 10 days, said Richard E. Gans, PhD, founder and CEO of the American Institute of Balance, which has eight clinics in the Tampa and Orlando, FL, areas.

Vickie B. Dionne, AuD
Richard E. Gans, PhD
When patients don’t recover within that time frame, they may then move into a post-concussion syndrome profile. Vestibular rehabilitation is being used to treat many of these patients, he said.

RAISING AWARENESS
As part of future research, Dr. Dionne would like to conduct hearing evaluations in student athletes with concussion and evaluate how long any identified cognitive or auditory processing disorders take to resolve.

Testing for auditory processing disorder would be a valuable addition to the program because such deficits could mean students are functioning poorly in class.

Further studies comparing different approaches to diagnosing and treating the audiological consequences of concussion would be welcome, as would registries tracking the results of patients seen for mild TBI, the testing performed, and subsequent outcomes, Dr. Day said.

The audiology community also needs to establish best practices for assessing mild TBI and monitoring recovery.

“We need to continue to increase audiologists’ awareness of the diverse sensory and communication disorders that may result from a TBI so that a team-oriented, patient-centered rehabilitation plan can be formulated and implemented efficiently, thereby enhancing the likelihood of improved outcomes,” Dr. Myers said.

FOR MORE INFORMATION
The government, the American Speech-Language-Hearing Association (ASHA), and other organizations offer resources on the diagnosis and management of concussion, including the auditory and vestibular side effects.