

CONCUSSION EVALUATION AND MANAGEMENT: PRE-SEASON, SIDELINE, AND OFFICE

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Concussion is a public health epidemic and we, as neurologists, are central in management of traumatic brain injury. Unfortunately, many neurologists have had minimal training during residency for the assessment and management of concussion. It is important to review the essentials for pre-season testing, sideline assessments, and in-office evaluation and management of concussion which will guide return to learn and return to activity decisions.

Pre-season or pre-participation counseling and assessments are important not only for patient education, but also for the sideline and office evaluation of concussion. The AAN evidence-based practice recommendations include pre-participation counseling regarding concussion and risk factors for a concussion as well as prolonged recovery from a concussion.¹ Pre-season assessments may also serve an essential role in removal from play and return to play. Pre-season assessments may include a baseline graded symptom checklist, King Devick baseline test², and computerized neuropsychometric testing. Completion of computerized neuropsychometric testing, when correctly completed and interpreted, can be helpful to determine baseline cognitive function and appropriate return to activity.

When counseling athletes, parents, or teams about sideline assessments, the most important factor to emphasize is to remove an athlete from play until formally evaluated by a healthcare provider. When in doubt, sit them out, and check them out by a healthcare provider. For any rapidly progressive symptoms, an emergency room evaluation is necessary to rule out intracranial injury, including hemorrhage. Athletic trainers are essential and can effectively serve as sideline healthcare providers. Sideline assessment tools are still in evolution, but currently we use the King Devick Test (KDT)⁴ and the Sports Concussion Assessment Tool (SCAT3)³ which includes the symptom checklist, a cognitive screen, and measure of balance. The SCAT3 must be completed by trained healthcare providers including athletic trainers. The post injury KDT is compared to the baseline KDT. If an athlete makes an error or is slower than the baseline, they should be removed from play until formally evaluated by a healthcare provider. The KDT can serve as a remove from play sideline screening tool.⁴

The majority of neurologists may not be involved with pre-participation assessments or sideline evaluation of athletes; however, many will be seeing these patients in the office for evaluation and management of concussion.

First of all, the outpatient evaluation of a concussed patient should be prioritized and, if possible, emergency appointment slots should be held for these patients. Concussed patients, specifically athletes, should be seen within 72 hours of injury to ensure appropriate management, to limit symptom exacerbation, and to prevent premature return to learn and play. During the appointment the key history components include the following:

- Injury characteristics: date of injury, post injury day number, injury description including the mechanism of injury, location of impact, loss of consciousness, presence or absence of retrograde or anterograde amnesia, immediate and delayed symptoms or signs.
- A graded, standardized postconcussion symptom checklist, which reviews the most common symptoms present after a concussion, will provide a systematic approach to obtaining the history. It is important to review symptoms from multiple domains, including physical, cognitive, emotional, and sleep.
- There are multiple risk factors for a prolonged recovery after a concussion including pre-injury history of headache and migraine, developmental problems or learning disabilities, psychiatric disease, and prior concussions.¹ It is important to note the number of prior concussions, symptom duration, and presence of a reduced threshold for having a concussion.
- A detailed history of headache characteristics including screening for red flags such as focal neurologic symptoms, altered level of consciousness, postural or positional component, progressively worsening headache, or intractable vomiting with headache. If red flags are present, neuroimaging is needed to evaluate for structural abnormalities that need to be addressed. If there is a postural or positional

component where the headache resolves when lying flat, order an MRI Brain with and without contrast due to high suspicion of a low pressure headache due to cerebrospinal fluid leakage postinjury. After red flags have been ruled out, obtain history regarding duration of headache, quality and severity of pain, location of pain, and associated features including sensory sensitivities, nausea/vomiting, exacerbation with movement, unilateral cranial autonomic features, and/or neck pain.

- Medication history, both since the head injury as well as prior to the head injury; allergies; past medical history; family history; and social history, including level of education.
- Determine if any form of baseline or pre-season testing has been performed including computerized neurocognitive testing, King Devick Test (KDT), neuroimaging, or neurologic examination.

The physical examination should include, but is not limited to the following key components. Use your clinical judgment to add other pertinent parts of the examination.

- Vitals, including orthostatic vitals
- HEENT: looking for areas of ecchymosis, abrasions, swelling, allodynia, tenderness to touch and palpation, otorrhea, rhinorrhea, Dix-Hallpike maneuver, range of motion of the neck, and identification of trigger points
- Musculoskeletal: looking for any abrasions or ecchymosis, range of motion, pain with movement and/or palpation
- Detailed neurologic exam:
 - Mental status exam, many use the Standardized Assessment of Concussion (SAC), but the minimal mental status exam (MMSE), Kokmen short test of mental status, and Montreal Cognitive Assessment tool are better, well-validated tools to assess mental status
 - Cranial nerve examination is critical
 - CN I: Presence or absence of anosmia
 - CN II: Presence of symmetric pupils and normal pupillary light reflex
 - CN III, IV, VI: When testing CN III, IV, and VI, a complete and thorough evaluation of extraocular eye movements, eye movement coordination, and efficiency of eye movements should be examined.⁵
 - Presence or absence of nystagmus
 - Smooth pursuit: track finger in all cardinal directions
 - Vergence: near point convergence (NPC), NPC > 6 cm is abnormal
 - Saccades: look rapidly from one target to another
 - Vestibulo-ocular reflex: rapid head thrusts during image fixation
 - KDT, which is a rapid number naming test that requires efficient saccadic function in addition to intact attention and language
 - CN V: Presence or absence of facial sensory loss or allodynia
 - CN VII: Presence or absence of facial weakness or paralysis
 - CN VIII: Presence or absence of hearing loss or vertigo with head movement, Dix-Hallpike maneuver
 - CN IX/X/XII: Uvula position, gag reflex, if indicated, tongue midline
 - CN XI: Weakness or paralysis of SCM or trapezius
 - Motor exam, include techniques looking for subtle weakness
 - Reflexes
 - Sensory exam
 - Coordination
 - Gait, including Romberg and timed tandem gait
- Concussion toolbox²
 - KDT, which is a rapid number naming test which requires efficient saccadic function in addition to attention and language
 - Neuropsychological testing
 - Computerized neuropsychometric screening tools
 - Gold standard, paper and pencil neuropsychometric testing
 - Objective vestibular testing
 - Autonomic testing
 - Neuroimaging: Unless intracranial bleeding or skull fracture is suspected, a CT Head is unhelpful. However, an MRI Brain may demonstrate microhemorrhages in susceptibility-

weighted imaging, microstructural injuries in diffusion tensor imaging (DTI), metabolic changes in MR spectroscopy (MRS), or other abnormalities.

Treatment is symptomatic while the brain injury heals. The most common symptoms and specific treatment options are the following:

- Headache: Headache is the most common symptom after a concussion. A post-traumatic headache (PTH) is treated based on the phenotype of headache.⁶ The most common phenotype is migraine. Headache expert consensus is that early and aggressive treatment of PTH may prevent persistent headache. Since the majority of PTH is of migraine phenotype, migraine treatment should be initiated as soon as possible.⁶ It is important to establish an acute strategy with strict limitations to practice primary prevention of medication overuse headache. If the headache is persistent, continuous, and/or frequent without improvement over 3-4 weeks, consider initiating preventive treatment.
 - Use a systematic approach for the treatment:
 1. Look for red flags
 2. Identify phenotype
 3. Elicit prior history of headache
 4. Initiate acute treatment early, within days
 5. Monitor for medication overuse
 6. Consider preventive treatment, within weeks
 7. Look for and address comorbidities
- Neck pain: physical therapy, other manual therapies, and/or trigger point injections
- Autonomic symptoms: conservative management including high volume hydration, increased salt, compression stockings, avoiding hot baths/tubs and large meals
- Vestibular or balance symptoms: vestibular therapy
- Eye movements: vision therapy
- Cognitive: cognitive rehabilitation/therapy
- Emotional: biofeedback, cognitive behavioral therapy, psychotherapy, cognitive restructuring/reassurance
- Insomnia: melatonin, which may help with sleep and headache

Strict rest with limited sensory stimulation should not exceed 24-72 hours post-injury. After the hyperacute stage of the concussion, it is important to initiate symptom-limited cognitive and physical activity. A recent study demonstrated that concussed subjects assigned strict rest for 5 days regardless of symptoms had higher symptom severity scores and a slower symptom recovery compared to 1-2 days of rest followed by symptom-limited return to school and activity.⁷

If the concussed athlete is in school, she/he will likely require academic accommodations in the learning environment to help with symptom exacerbation and to facilitate return to learning. Typically, adjustments are short-term and do not require a 504 plan or IEP.⁸

Symptom-limited return to physical activity can be used as a treatment approach. The Buffalo Concussion Treadmill Test (BCTT), controlled aerobic exercise, has demonstrated symptomatic improvement⁹ as well as faster normalization of cerebral blood flow abnormalities during a cognitive task.¹⁰ Provide prescriptive instructions regarding exercise, increase intensity slowly under close monitoring, and ensure the absence of symptom exacerbation. Once the exertion protocol has been completed, initiate a sport specific return to play protocol.¹¹

Once the concussed patient is symptom-free at rest, is at school without accommodations, and has completed a full exertion protocol and sport specific return to play protocol without symptom exacerbation, returning to full practice and game play can be considered.¹ Objective measures of rapid number naming and eye movements (KDT), vestibular function, and cognitive function must return to valid baseline scores prior to full contact practice and game play. Prior to providing medical clearance and returning to sports, re-establish baselines and counsel the patient that a prior history of concussion is a risk factor for future concussion.

Physical activity and sports play a very positive role in all individuals, especially our youth, in the face of the digital world, metabolic syndrome, diabetes, and obesity. However, we must recognize the potential dangers of concussion and brain injury, both short term and long term. Mismanagement can be devastating. Appropriate, specific, and timely management of concussion can make the difference between short term symptoms with

resolution and persistent symptoms and lifelong difficulties. We, as neurologists, are uniquely equipped to be a critical member of the management team to guide care from the initial assessment to treatment and ultimately to provide medical clearance prior to returning to full cognitive and physical activity.

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