Concussion/mild traumatic brain injury (TBI) is a health care challenge of the twenty-first century. There has been greater awareness and focus on concussions, especially those related to sports trauma, and specifically football related head injuries. Increased public awareness of the possible long-term consequences of traumatic head injuries, even when mild, followed reports of former football players who exhibited signs of depression, memory changes and alterations in personality following mild TBI. These changes have now come to be known as chronic traumatic encephalopathy (CTE). Unfortunately, some of these players committed suicide. Postmortem brain analyses have revealed specific changes in the brain that have now been associated with concussion and identified as CTE (1).

Recent U.S. military operations in the Persian Gulf have also brought greater awareness to the public domain about the neurocognitive effects of concussion/mild traumatic brain injury. Post deployment personality changes in some service men and women have been attributed to traumatic head injuries and concussion (2,4).

There were about 2.5 million reported emergency room visits in 2010 for head injuries (3). Greater than 90 percent of these are a result of concussions and/or mild traumatic brain injuries (3,9).

Care of traumatic head injury patients is associated with significant health care related expenditures globally (5). Additionally, lost productivity from brain injuries is associated with a greater indirect societal cost.

This review is intended to address return to work after a concussion in nonmilitary or professional sports careers.

**What is concussion?**

Concussion is a blow, jolt or a translational force to the brain. (Continued on page 2)
head that disrupts normal brain function. Concussion is a subset of mild traumatic brain injury. This distinction is important as there are other forms of mild traumatic brain injuries which are not concussions. Gross imaging findings of brain tissue perturbations, such as cerebral contusions and intracranial bleeds, can be readily identified via computer tomography (CT) and magnetic resonance imaging (MRI) in other forms of mild traumatic brain injury. However, these findings are typically not seen in concussions.

Post concussive syndrome refers to a specific constellation of symptoms that can occur after a concussion. These symptoms include cognitive changes, headaches, dizziness, light sensitivity, sound sensitivity and visual perception changes. Additional symptoms include balance impairment, anxiety, depression, anger, behavioral changes, sleep disturbance and fatigue. When three or more of the aforementioned symptoms persist after a concussion event, they are clustered as post concussive syndrome (6).

The two leading causes of concussions are falls and motor vehicle accidents (MVAs) (3). Fall related concussions are most common in those aged 65 and above (3). MVA related concussions play a significant role in disability in the 15-45 age group (3).

**Pathophysiology**

There has been significant attention and research dedicated to elucidation of the pathophysiology of concussions and post concussive syndrome. However, our current understanding of a unifying cellular pathophysiology as it relates to the various symptoms remains limited. It is, however, known that direct or translational mechanical forces with head trauma can result in structural axonal damage (7). Animal pathological brain studies close to a concussion event have identified axonal damage at a microscopic level (8). The changes in cellular structure, lead to perturbation of various neurotransmitters, ions and ATP, and these result in the manifestation of some of the aforementioned symptoms of the post concussion state (6).

**Return to work**

Return to work after concussion can be viewed in general terms as return to “gainful employment.” The goal in this patient population is to return to pre-injury work duties and performance at pre-injury level. However, work restriction may be indicated. Those who are able and willing to seek employment requiring partial or sustained accommodations should be identified for implementation of reasonable alterations to the work environment. In order to achieve a positive outcome in the return to work process, cooperation of patients, family members, support groups, clinicians, employers, supervisors and third parties (adjusters, insurance carriers), all working towards this common goal is a must. Conversely, termination of work duties, poor productivity and job restrictions not suitable for the patient or the employer are considered less desirable outcomes.

In a study conducted by de Koning and colleagues, as high as 33% of mild TBI patients did not return to work a year after their injuries (10). Furthermore, one study found a high rate of job status changes in concussion patients (11). Although there are many contributing factors causing a job status change and lack of a return to work, those that the clinician can impact to improve successful return to work will be discussed here. For the clinician treating workers who have sustained a concussion, appropriate diagnosis and treatment of symptoms should be the goal to help facilitate a successful return to work. Also, when appropriate, the clinician should make recommendations for work accommodations based on understanding of clinical needs.

**COMMON AND IMPACTFUL POSTCONCUSSIVE SYMPTOMS**

**Headaches**

Headaches are a common source of morbidity in those who experience post concussive syndrome (12, 13) and can be of differing etiology and character. The main categories of post traumatic headaches are Migraine, Cervicogenic, Tension and Mixed.

The assessment and determination of headache type helps to tailor appropriate therapy. Furthermore, a detailed history is important in identifying patients with a prior history of headaches, as those will likely be exacerbated (14).

1. **Migraine type:** Migraine is a common type of post-concussion headache (15). Like other migraine headaches, typical triggers include light and sound. Though patients in the post concussive state can experience photophobia and phonosensitivity, those with post concussive migraine report direct association of sound and light as triggers of their headaches. These headaches can occur with or without an aura, and at times associated with other symptoms such as nausea. Post concussive migraine headaches respond to calcium channel blockers, beta blockers, tricyclic antidepressants, anti-epileptics and triptans. Patients who have frequent headaches should be considered for prophylactic medication to decrease the headache frequency, in addition to abortive agents.

2. **Tension type:** This type is provoked by stress and a high level of activity. Patients in this group typically report high activity levels, either cognitive or physical, as primary triggers, excluding the other triggers identified in the former subtype of headache. Besides activity modification, they can respond to NSAIDs or acetaminophen when NSAIDs are contraindicated or ineffective.

3. **Cervicogenic type:** This subtype of headache occurs after a concussion when neck/cervical spine pathology is the primary cause (16). Cervical disc herniation, nerve root compression, ligamentous injury and reactivation of cervical facet disease can be
Case 1: Illegal Substance Use History - The Commercial Driver Medical Examiner’s (ME) Dilemma: What to do if the response to QUESTION 31 is YES! A ME who participated in a NCOEM ME training session inquired about a driver’s “YES” response to the DOT’s Medical Examination Report Form (i.e. Form MCSA-5875), Page 2, question #31: “Have you used an illegal substance within the past two years?” The ME’s inquiry included two questions: (1) Is a YES answer an automatic disqualification, so I don’t need to do an exam? and (2) Why does the question state “within the past two years”?

Ron and Jay: FMCSA’s 49 CFR 391.41(b) (12) addresses substance abuse and states that a person is physically qualified to drive a CMV if that person: (12)(i) Does not use any drug or substance identified in 21 CFR 1308.11 Schedule I, an amphetamine, a narcotic, or other habit-forming drug.

Our recommendation would be to first review any written driver comments on MCSA-5875 page 2. Next the ME needs to review and discuss the driver’s answer and document the discussion in MCSA-5875 SECTION 2. Use of an illegal substance can be determined through the medical history and/or body fluid testing. Any additional substance testing, whether urine or hair testing, is not performed under DOT authority, but could be ordered as a medical test by the ME. It is ultimately a judgment call on the part of the ME whether there is active substance use and whether a medical test by the ME. It is ultimately a judgment call on the part of the ME whether there is active substance use and whether a medical test by the ME.

Remember that use of any Schedule 1 drug or substance results in medical disqualification. This includes marijuana – whether medicinal or recreational – regardless of the regulations regarding marijuana in the state issuing the commercial driver’s license.

Lastly, if it is determined that illegal substance use is present, then the ME needs to complete the medical examination, make a determination “does not meet standards,” and specify the reason for disqualification on the report form. This is outlined in 49 CFR 391.43(f)(2).

We declined to comment on FMCSA’s intent in including the criteria of “within the past two years” in this question, and suggested that the Office of Medical Programs be contacted if further clarification was needed.

Case 2: Abdominal Aortic Aneurysm. A driver in his mid-70s with a history of abdominal aortic aneurysm repair 8 years ago presented for a CMV exam. The ME contacts the driver’s Primary Care Provider (PCP) to discuss his status and is told that a follow-up study last year was “OK.” The PCP did not have specific information on the location or size of the aneurysm, or any details of the surgery. The driver has no related symptoms and otherwise meets the medical standards in 49 CFR 391.41.

Ron and Jay: Guidance for a driver with a previous abdominal aortic aneurysm repair contained in Dr. Hartenbaum’s “The DOT Medical Examination, 6th edition” has changed. Although the 5th edition guidance was to obtain a CT scan with contrast annually, the 6th edition now advises annual cardiovascular evaluation and clearance. This change can be found on careful review of the “Cardiovascular Recommendation Tables – 2009 Update” contained on page 180 of the 6th edition.

A FMCSA Medical Expert Panel recommended adding guidance to the current guidelines on certification of drivers with endovascular abdominal aortic repair. This recommendation, which was made in August 2015, can be found at: https://www.fmcsa.dot.gov/regulations/medical/recommended-changes-cardiovascular-disease-guidelines.

We suggest requiring additional information from the driver’s cardiovascular surgeon. If the driver has not had a follow-up visit within a “reasonable” time interval (for example, in the past 6 months) and/or information is not available, the ME could use “Determination Pending” for up to 45 days for the period the driver’s medical card is still valid. Alternatively, if the ME believes the driver to have a low risk of abdominal aneurysm leak, then a 3-month or 6-month card could be issued to allow the driver to complete the re-evaluation of the aneurysm repair.

Ron’s News from AOHC Session 206 “Commercial Driver Medical Examination Updates and Issues” (4/30/18, New Orleans)

The following are helpful tips for the ME obtained from the Chief of the Medical Program Division of the FMCSA, Christine Hydock, who presented at AOHC 2018:

- WEBSITE CONSTRUCTION UPDATE: The FMCSA website, not available since December 2017, is actively being revised. It still has limited functionality: National Registry Medical Examiner lookup is available using either the ME’s (1) office location zip code, or (2) FMCSA registration number. MEs can continue to conduct physical qualification examinations for CMV drivers and issue paper Medical Examiner Certificates (Form MCSA-5876) to qualified drivers. MEs should segregate all examinations completed during the website outage and be prepared to upload them to the National Registry system when it is back online, with no penalties. There is no projected date for restoration of full website functionality.

- Selection of a Chief Medical Officer for FMCSA should be announced by June 2018.

- The FMCSA ME Handbook is still under revision; it will be presented to the FMCSA Medical Review Board by July 2018.

- The previously announced June 22, 2018, requirement to report exam results by midnight of the day after the driver examination is now deferred to 2021. MEs should continue to issue paper Medical Examination Certificates.

- Periodic training for MEs is still being developed. The Agency will be “reasonable” in allotting adequate time once the free, online course is available. Training focus will be on apparent areas of ME weakness. No other ME periodic retraining will be accepted.

- New MEs may first train, then register (a change of procedure sequence), then take the certification test. However, no ME certificates can be issued at this time. Thus the
suggest that by 2070-2090, summer temperatures in New York and New England could rise to those now felt in Georgia. Sea levels are predicted to rise 18-39 inches by the 2080s. Similarly, it is worth reviewing some key facts about the impact of tick-borne diseases. The recent May 4th Vital Signs Report from the CDC described the profound increase that has been seen between 2004 and 2016 with regard to vector-borne diseases (those carried by mosquitoes, ticks, or other animals). Tick-borne diseases accounted for 77% of all vector-borne diseases and increased from 22,000 annually in 2004, to 48,000 in 2016. Of those, 82% were Lyme disease, which we know likely represents significant underreporting, as many tick-borne infections, including Lyme, can be difficult to diagnose clinically and laboratory testing is not always optimal. CDC maps of the extent of reported Lyme cases speak volumes, as shown in these maps referencing the regions impacted in 2001 compared to 2013.
accurate and it varies substantially both between and within states. And while it would be nice, we cannot simply run a randomized controlled trial, warming some states relatively more than others and watching what happens to ticks and patients. However, we do not have to run such a trial because nature has done this already. For example, New England, like other northern regions of the US, is cooler at baseline than the southeast. Thus, an increase in summer temperatures of, say, 5°C from 80–85°F in Boston is a larger relative increase than the same 5°C increase in Miami where it may already be 90-100°F or higher in the summer. Of course, that 5°C increase may be more damaging in southern states where temperatures are already near the maximum of tolerability for plants, animals, or people. But regarding ticks, which prefer warm climates to cool ones, it would stand to reason that the increase from cool to warm or warm to hot in the northeast (or the north in general) may be more favorable to tick migration and thus disease events, than climate change-induced temperature changes elsewhere in the country. A study from 2013 in the Canadian Medical Association Journal examined just this question and found, in fact, that this was exactly the case. More northerly states in general showed increases in the incidence of Lyme disease while southern states showed either no change or a decrease (presumably as it becomes too hot for the ticks to handle). One figure from this paper is striking:

While there could be other confounding variables such as movement of people and increasing suburban sprawl, it certainly fits the model one would expect given the temperature effects of climate change.

In addition to Lyme disease moving north as states warm, an association of Lyme and tick-borne infections with climate change should lead existing Lyme areas to see longer tick seasons. One would expect earlier starts due to warmer springs and longer spring-summer-fall cycles. Tick activity spreading into the winter should also be seen with odd warm spells that are increasingly seen in winter months. And here too, the data mirrors what we would expect. Anecdotally and empirically, Long Island has seen increasingly long tick seasons and incident cases of tick-borne infections occurring during warm spells in winter months, and this is expected to worsen. Using current and past data, and various climate change models, the onset of new incident cases of Lyme disease is expected (Continued on page 6)
I have been practicing Occupational Medicine for more than 25 years and am proud to be an ACOEM Fellow and a member of the New England, New York and Western chapters. Currently, I work as Vice President and Corporate Medical Director for AllOne Health, in Boston. Here, I lead the National and Absence Management teams. In addition, I serve as the Medical Director of the Employee Health Program at the Boston Medical Center. The position at BMC brings me back full circle to Boston where I graduated from Boston University Medical School in 1986.

Just prior to coming back to Boston, I served as the Medical Director of Employee Health, Safety and Wellness for the Mount Sinai Health System in New York. There, I oversaw the health and wellbeing of their 36,000 staff members at 7 hospital locations. In addition, while at Mount Sinai, I was the Medical Director of the Selikoff Centers of Occupational Health which included 4 Occupational Medicine clinics and the World Trade Center Responder Health Program. Living and working in Manhattan was a big change from California where I had spent 20 plus years. For the majority of the time in California, I led the Occupational Health Services at the University of California in San Diego. Simultaneously, I built a large private practice serving the occupational health needs for a multitude of companies and industries in the area.

I am enjoying being back in Boston, which is where it all began for me, and rejoining NECOEM.

References

Dr. Saul Hymes is Medical Director of Pediatric Antimicrobial Stewardship and Assistant Professor of Clinical Pediatrics, Pediatric Infectious Diseases at Stony Brook Children’s Hospital, SUNY Stony Brook.
sources of cervicogenic headaches. Though post traumatic CSF leak can have a component of cervicogenic and migraine features, this type of headache falls into a different cluster in terms of management and treatment. Comprehensive evaluation including assessment for motor weakness, sensory abnormalities, otorrhea and rhinorrhea helps to avoid missing cervical spine pathology and other serious causes of post traumatic headache. Cervical and skull base imaging with MRI or CT and EMG when appropriate, will help clarify the diagnosis and further assist in the treatment. Cervical injections (trigger points, facets, epidural), physical therapy and medication management can be effective in the appropriately diagnosed cervicogenic headache.

4. Mixed type: This subclass has features of some or all of the prior categories or present with symptoms that do not confine the diagnosis to a particular subtype. These headaches tend to be more complex in nature and can be difficult to treat. A comprehensive approach with trigger avoidance and combination treatment and at times psychological support in select cases can be useful.

Visual field changes
Visual field impairment after a concussion can be a barrier to return to work (18). Visual perception changes can affect driving ability, reading, computer use and visual field scanning. Patients may complain of blurry vision, change in depth perception and difficulty driving due to blurry vision. Accommodation and convergence insufficiency are common causes of visual field impairment after concussion in those without gross peripheral or central visual path structural defects. In those with accommodation and convergence insufficiency, typical complaints can include headaches and eye fatigue with reading or close work, words coming in and out of focus, objects and words appearing to float and difficulty focusing or using computers (19). Assessment of accommodation, convergence and saccades through physical examination can help screen patients. Patients with significant visual field symptoms should be screened and referred to eye doctors for evaluation and/or vision therapy.

Cognitive Impairment
Cognitive changes can be a barrier for successful return to work in the concussion patient. Complaints include changes in the speed of thinking, slow cognitive processing and impaired attention. Other complaints may include word retrieval and word finding difficulties. A thorough history, including pre-morbid attention deficit, learning disability and family history of cognitive deficits can aid in further testing and treatment. In those with significant risk factors identified on history or with concerning cognitive complaints, neuropsychologic testing should be considered. Though addressed separately below, mood symptoms and deficits can also affect cognition (20). A comprehensive neuropsychologic evaluation can aid in identification and characterization of psychosocial factors. Cognitive therapy, psychotherapy and/or medication management can be useful for short, intermediate or long-term return to work planning for patients with cognitive complaints.

Psychological
Depression, anxiety, irritability and fear of return of symptoms can influence work return. Post traumatic depression has been shown to impact several post concussive symptoms such as headache, fatigue and cognitive impairment (20). A comprehensive history of pre-injury mood disorders such as depression and anxiety should be taken in post concussive patients. It is not uncommon for patients with controlled depression and anxiety to present with exacerbations in the post-concussion state. This group, along with those with particularly emotionally traumatic causes of head injuries, greatly benefit from early psychologic support to facilitate return to work. Care should be taken in reflexively prescribing anti-anlytics as some have been shown to negatively affect memory in the traumatic brain injury patient.

Post traumatic vertigo
Dizziness and balance complaints are common post concussive symptoms. In assessing patients presenting with these symptoms, a thorough history and examination and a dynamic balance assessment can help screen for the need for further testing and evaluation. Referral to ENT for unilateral tinnitus can be considered. Vestibular physical therapy is beneficial for post traumatic vestibular dysfunction. When left untreated, vestibular dysfunction can prolong recovery from concussions (23).

Motivation and other Factors
Secondary gain and litigation can influence return to work (24). Though these factors are difficult for the practitioner to control, it is important that the clinician focuses on thorough assessment and management of appropriate symptoms, regardless of presenting circumstances. An objective return to work plan and approach can ease stress and ameliorate tension due to these or other factors beyond the clinician’s control.

CONCLUSION
This review discusses the clinician’s approach to return to work in post concussive patients. The review addresses many clinical factors that affect individual return to work but focuses on the most common clinical factors. There are other factors that were not discussed in detail or emphasized in this review such as occupation specific unique considerations for return to work (e.g. safety sensitive jobs such as pilots), concussions with associated orthopedic injuries, and patient motivation. This review hopefully can assist the treating clinician in a comprehensive evaluation of patient with concussions and thereby help expedite successful and timely return to work.

Dr. Kwame Asante, MD is a board-certified PM&R specialist in Hartford, CT.

References
Dr. Rudolf Virchow

Dr. Rudolf Virchow (1821-1902) has notably made a mark not only in the field of pathology but has been referred to as the founder of social medicine. He authored a comprehensive report on the clinical picture of typhus and identified social factors such as poverty and lack of education as key elements in the development of a typhus epidemic in the Prussian province of Upper Silesia in 1847-1848. He coined a well-known aphorism: "Medicine is a social science, and politics is nothing else but medicine on a large scale". He developed the first systematic method of autopsy involving surgery of all body parts and microscopic examination. A number of medical terms are named after him, including Virchow's node (left-sided supraclavicular lymph node) and Virchow's triad (Hypercoagulability, Hemodynamic changes of stasis and turbulence, and Endothelial injury/dysfunction - as causative factors of thrombosis). He was the first to use hair analysis in a criminal investigation. Dr. Virchow was an outspoken advocate for public health. His writings and teachings are full of observations and recommendations about ways to improve people’s health by improving their economic and social conditions.

Diagram/content credits: Wikipedia, Myron Schultz (Emerging Infectious Diseases, Sept 2008) and others.

The following members sent in correct responses:

Teresa Allen, MD  Anne Riemer, PA-C

Congratulations!!

“What/Who Is It” features a series of trivia, facts, figures, etc. related to the field of occupational medicine. If you have any such interesting or fun-filled material, please e-mail Dr. Karandikar at dr_abhik@yahoo.com. All material should be related to the specialty of occupational and environmental medicine and have an educational, inspirational, historic or other relevant value.