You're the Flight Surgeon

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You're the flight surgeon at a busy U.S. Air Force (USAF) flight medicine clinic, where you are brought a partial record of a Reserve Officer Training Command cadet for review prior to an initial flying class (IFC) I pilot physical exam. This cadet is a 24-yr-old man in his final year at a local university with a history of head trauma while snowboarding 1 yr prior. On record review, notes indicate that he had a 20-s loss of consciousness (LOC) with approximately 6 h of altered mentation. He was brought to a local emergency department for evaluation, with reports of a normal computed tomography scan of his head without evidence of bleeding or other acute injury. His presenting Glasgow Coma Scale (GCS) was 15, with a discharge GCS of 15. Emergency department records, including the computed tomography scan, were not available for review. A note by his physician states he is otherwise healthy without residual sequelae from his injury and his neurological exam is normal.

1. Based upon the above information, how would you categorize the severity of his head injury?

A. Mild.
B. Moderate.
C. Severe.
D. It depends on the classification system.

ANSWER/DISCUSSION

1. D. Generally, head injury/traumatic brain injury (TBI) can be classified as either focal or diffuse, where focal injuries are localized and occur at the site of impact and diffuse injuries are widespread, resulting from the shearing of axons secondary to acceleration and deceleration forces.[2,4] There are several classification schemes on the severity of head injury that are usually based on clinical factors, including the duration of LOC, amnesia, the GCS, and neural imaging.[2,12] The Department of Defense and Department of Veterans Affairs stratify severity based on length of LOC, alteration of consciousness and posttraumatic amnesia, neuroimaging, and the GCS measured at or after 24 h.[2] To be classified as mild, structural imaging must be normal, with LOC 0-30 min and posttraumatic amnesia no greater than 1 d. According to the Department of Defense and Department of Veterans Affairs stratification, this cadet's head injury is considered mild. In the USAF, severity of head injury uses similar clinical indicators; however, the injury is considered aeromedically moderate if there is LOC and/or amnesia greater than 30 min and less than 24 h.[9] Similar nuances are also seen in the U.S. Navy and Federal Aviation Administration stratification that places our cadet in the moderate category.

Prior to your visit with the cadet, you have his primary care physician order a brain magnetic resonance imaging (MRI), electroencephalogram, and a consultation with a local neurologist based on the evaluation requirements of the USAF Waiver Guide for aeromedically moderate head injury.[9] Routine and sleep-deprived electroencephalograms do not show evidence of eliptiform activity, and the neurologist reports a nonfocal neurological exam. However, the brain MRI with and without contrast is read as "multiple, too numerous to count, foci of T2/FLAIR [fluid-attenuated inversion recovery] hyperintensities scattered throughout the deep central and subcortical white matter with one noted superior to the body of the left corpus callosum." While history does not reveal any neurological deficits and his exam is otherwise normal, the neurologist orders further studies, including serum labs and repeat neuroimaging, and recommends proceeding with lumbar puncture. His serum labs, including complete blood count, comprehensive metabolic panel, coagulation panel, erythrocyte sedimentation rate, C-reactive protein, antinuclear antibody, antineutrophil cytoplasmic antibody, angiotensin converting enzyme, Lyme, and human immunodeficiency virus, are normal. Examination of cerebrospinal fluid for cell count, protein, glucose, oligoclonal IgG bands, levels of myelin basic protein, and infectious markers is normal. Repeat MRI of the brain with and without contrast, as well as MRI of his cervical spine, shows multiple white matter lesions, otherwise unchanged from the previous study 4 mo prior, as well as a normal cervical spine MRI.

2. What is your working diagnosis?

A. Clinically isolated syndrome (CIS).
B. Multiple sclerosis (MS).
C. Acute disseminated encephalomyelitis (ADEM).
D. No definitive diagnosis is possible with present information.

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ANSWER/DISCUSSION

2. D. From the time the Schumacher criteria for the diagnosis of MS described it as central nervous system (CNS) lesions disseminated in space and time, little has changed from the clinical perspective, although newer criteria using paraclinical findings, including MRI and cerebrospinal fluid, have led to the revised McDonald criteria, most recently updated in 2010.[7,11] Central to the diagnosis is an MS attack with objective clinical evidence of a CNS lesion.[11] When there is a single clinical attack with clinical evidence of one lesion, this is termed CIS, which places the patient at risk of further relapses. In the Optic Neuritis Treatment Trial, the probability of developing MS at 15 yr after a single clinical episode of optic neuritis without baseline MRI lesions was 25%. If there was a brain MRI lesion at baseline (CIS), the risk was 72%.[10] There is no historical evidence of an MS attack in our cadet. ADEM is similar to MS, where both involve autoimmune demyelination of the CNS. It typically follows a viral infection or immunization, manifesting as acute onset of multifocal neurological signs. ADEM typically follows a monophasic course, although multiphasic ADEM has been described, further confusing its picture from MS.[6,13]

You see the cadet for completion of his IFC I history and exam. He is an otherwise healthy 24-yr-old right-handed man without any significant past medical or surgical history. He denies any current or remote history of changes to vision, weakness, paresthesias, gait abnormalities, or known neurological concerns. He has never been hospitalized for illness and his immunizations are up to date without any known side effects after administration. He has never taken any prescribed medications and he denies any illicit drug or alcohol use. He also denies the use of herbals or supplements. He eats well and does not have any dietary concerns. To his knowledge, he was born at term without complications and met all of his developmental milestones. He has a history of participating in multiple team sports, including football and wrestling, and he feels lucky that he was never injured during his playing years. His only significant injury was his snowboarding accident that drove his recent work-up. Collateral history is obtained from his mother, who confirms he did, in fact, meet all of his developmental milestones and was otherwise healthy growing up. She reports, however, that he was born after a prolonged labor and was delivered by caesarian section secondary to an indication of fetal distress seen on electronic fetal monitoring. She reports that his APGARs were 9 and 9 at 1 and 5 min of life and denied any need for intervention, including supplemental oxygen or observation in the intensive care unit. A general physical exam is normal and you confirm that his neurological exam is nonfocal.

3. What is your best next step?

A. This cadet is normal. Forward his aeromedical summary for approval immediately.
B. Consult neuropsychology.
C. Tell him that MS/CIS has zero approved waivers for flying class I and he should think of a different career field.
D. Consult another neurologist for a second opinion.

ANSWER/DISCUSSION

3. B. For any aeromedically moderate head injury, it would be prudent to obtain a neuropsychological evaluation, including assessment of general cognitive functioning, memory, attention/concentration, mood, and a clinical interview.[9] While the association between head injury and cognitive impairment is well established, cognitive dysfunction is also a significant feature of MS/CIS, with impairment ranging between 40–65% affected.[5] It is true that no flying class I's have been approved for waiver by the USAF. However, this cadet does not have the diagnosis of MS/CIS and, despite his normal exam, this case is not normal due to his MRI findings and will need further review. After his neuropsychological evaluation, this cadet will need to be seen by the Aeromedical Consultation Service (ACS) at Wright-Patterson Air Force Base, OH, for further expert consultation.

This cadet's neuropsychological evaluation is otherwise unremarkable, with average to above average scores in cognitive functioning, memory, and attention. He does not have significant findings of a mood or thought disorder. You compile all of his civilian records and include them in your write-up, which is then sent to the waiver authority who, not surprisingly, requests ACS evaluation. At the ACS, he is evaluated by several consultants. A thorough history, exam, and repeat imaging of the brain and spinal cord confirm prior findings without significant changes. He has a transthoracic echocardiogram with agitated saline bubble study that confirms the absence of an atrial septal defect or a patent foramen ovale. Repeat neuropsychological testing is also nondiagnostic and essentially unchanged from his prior civilian work-up. He is recommended for an IFC II [remotely piloted aircraft (RPA) only] waiver and disqualification for IFC I.

4. What are your aeromedical concerns?

A. Any acute neurological impairment exacerbated by stressors of flight (hypoxia, fatigue, etc.).
B. Cognitive impairment with potential for degradation of performance.
C. Risk of sudden incapacitation from seizure.
D. Potential long-term risk of early or accelerated cognitive decline.
E. All of the above.

ANSWER/DISCUSSION

4. E. The only concrete diagnosis that this cadet has is a history of aeromedically moderate TBI. With any head injury, there is an elevated risk of seizure over the general population and, with a moderate head injury, that risk is elevated for over 10 yr,[1] although the aeromedical risk is acceptable much sooner.[9] Residual cognitive and neurological impairment are also aeromedical concerns.

While his history of moderate TBI is certainly a concern, a more interesting discussion is developed regarding his multiple white matter hyperintensities. These lesions are not specifically disqualifying for either military retention or from aviation duties under the USAF Medical Standards Directory.* This is also true of U.S. Navy, U.S. Army, and

* U.S. Air Force. Medical standards directory; 2013. [Accessed 10 Nov. 2014]. Available to those with access from https://kx2.afms.mil/kj/kx4/FlightMedicine/Documents/Medical%20Standards%20Directory%20(MSD)/MSD%202013-Dec-2.pdf.

Federal Aviation Administration policy. However, without a known etiology, it is difficult to predict the specific risks in flight, as there is a paucity of data regarding these individuals when exposed to environments of hypoxia and other stressors of flight, including temperature extremes, decompression sickness, acceleration effects/G forces, etc. According to a meta-analysis by Debette and Markus, individuals with incidental white matter hyperintensities appear to be at increased risk of stroke, dementia, and death.[3] However, our population would be significantly younger than the age at which these concerns would arise.

A recent study looking at the high-altitude U-2 community found a significant increase in volume of white matter hyperintensities compared to age-matched controls.[8] None of these pilots were grounded or required a waiver to continue flying duties. Our cadet's MRI findings are different in distribution compared to the U-2 pilots. Both the U-2 pilots and our cadet were asymptomatic without an identifiable insult that would cause the white matter hyperintensities, although it is assumed that the hypobaric environment of the U-2 cockpit is the culprit. The key difference between these aviators and our cadet is that the U-2 pilots are already rated and our cadet is still an untrained asset with significant MRI findings that have too many uncertainties with our current level of knowledge. These uncertainties drive the ACS recommendation of IFC I disqualification. The operational stresses of RPA operations are felt by the ACS to be aeromedically safe for this cadet and result in the IFC II (RPA only) recommendation. Follow-up is crucial to see how the patient does both clinically and radiographically throughout his USAF career.

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A 40-yr-old male A-10 pilot reports to your flight clinic with a complaint of persistent right elbow pain and weakened grip strength for 2 wk. A thorough but focused history reveals that he had similar symptoms 10 yr ago that resolved without treatment. The pain has moved into a new location in his elbow and was brought on by yard work and house renovations. He denies any trauma and states that he does not experience pain during in-flight tasks, but that the pain is exacerbated by activities such as grabbing flight manuals from a shelf and lifting his flight bag, and he has noticed difficulty with shaking hands. He denies neck pain, but has pain when fully extending the elbow. He has tried icing the elbow, but he has not taken any medication to relieve his symptoms for fear of being removed from his flying duties. He is otherwise healthy and denies constitutional symptoms. He is not on any regular medications and has no known drug allergies. Other than mild ankle sprains, he has no significant medical history. He does not smoke and admits to one glass of wine three times a week. He is an avid runner and biker. His vital signs are stable and within normal limits. Upon physical exam, you discover point tenderness at the lateral epicondyle, pain with passive flexion of the wrist, and pain with resisted wrist extension when the elbow is extended versus when the elbow is flexed. There is no pain with extension of the

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