How to Recognize a Concussion -- Presenter: Steve Devick (2hrs)

Course Description:
Sports-related concussion has received increasing attention as a result of greater awareness of concussion risk and the short- and long-term neurologic sequelae of these traumatic brain injuries. This course gives an overview of the biomechanics of concussion, an evidence-based review of screening and diagnostic tools, and insights into optometry's role in managing concussion.

Course Objectives:
At the completion of this lecture, participants will be able to:
• Describe concussion signs and symptoms
• Describe ocular motor sequelae associated with traumatic brain injury
• Describe the evidence-based sideline tools for detecting mild traumatic brain injury

Course Outline:
1. Introduction
   a. What is a concussion? (McCrory et al, 2009, 2013)
      i. Concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces.
      ii. Concussion may be caused by a direct blow to the head, face, neck or elsewhere on the body with an “impulsive” force transmitted to the head.
      iii. Concussion typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously.
      iv. Concussion may result in neuropathologic changes but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury.
      v. Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course however it is important to note that in a small percentage of cases, post-concussive symptoms may be prolonged.
      vi. No abnormality on standard structural neuroimaging studies is seen in concussion
   b. Epidemiology:
      i. 1.6 to 3.8 million annually (Thurman et al., 1998; Guskiewicz et al., 2000; Langlois et al., 2006; American College of Sports Medicine 2006; Guskiewicz et al., 2003; Collins et al., 2003; Mitka 2010)
      ii. An estimated 85% undiagnosed (American College of Sports Medicine, 2006)
      iii. Boy’s football & Girls soccer highest rates (Halstead & Walter, 2010; Meehan et al., 2011)
   c. Concussion biomechanics (Meaney et al., 2011; Maruta et al, 2010)
      i. Contact force
1. Brain experiences accelerations at the moment of impact (Meaney & Smith, 2011; Maruta et al, 2010)
   a. Linear accelerations: Cause increased pressure throughout the brain leading to neurologic dysfunction
      i. Direct & indirect injury (coup & contrecoup)
   b. Rotational accelerations: cause shear-induced tissue damage & stretching of axons
2. Pathophysiology: Neuronal Injury (Meaney & Smith, 2011)
   a. Axonal stretching: microtubule and microscopic axonal injury
   b. Neuronal injury: biochemical cascade events (Giza & Hovda, 2001)
   c. Ionic imbalance: Glutamate, Potassium, Calcium
      i. Non-specific depolarization and initiation of action potentials
      ii. Release of excitatory neurotransmitters
      iii. Massive efflux of potassium
      iv. Increased activity of membrane ionic pumps to restore homeostasis
      v. Hyperglycolysis to generate more adenosine triphosphate (ATP)
      vi. Lactate accumulation
      vii. Calcium influx and sequestration in mitochondria leading to impaired oxidative metabolism
      viii. Decreased energy (ATP) production
      ix. Calpain activation and initiation of apoptosis
   d. Neurotransmission disrupted
   d. Vision and Eye movements during concussion
      i. Vision/oculomotor symptoms: photophobia (occipital lobe, brainstem), blurred vision (frontal, temporal lobes), diplopia and vertigo (brainstem, cerebellar paths) (Heitger et al, 2002; Heitger et al, 2010)
      ii. Anterior corona radiate (dorso-lateral prefrontal cortex, DLPFC) & corpus callosum (genu) most frequently damaged white matter tracts in mTBI determined by DTI (Maruta et al, 2010)
1. Gaze tracking error variability during visual tracking as a useful screening tool for mTBI. Gaze error variability significantly correlated with attention and working memory measures in neurocognitive testing DLPFC (Brodmann Areas 9 and 46) responsible for initiation of saccades (B-46), plays a major role in the decisional processes governing ocular motor behavior (Pierrot-Deseilligny et al., 2005)
2. Saccadic eye movements are controlled by a cortical network composed of several oculomotor areas: parietal eye field, frontal eye field, supplementary eye field, cingulate eye
field, and DLPFC. DLPFC in the midfrontal gyrus is involved in reflexive saccade inhibition and visual short-term memory (Gaymard et al., 1998)

2. Sideline Concussion testing
   a. Other testing methods (McCrorry et al 2009, 2013)
      i. SCAT2, BESS, Symptoms checklist, Cognitive Testing, SCAT3
   b. Eye movement screening
      i. Boxers & MMA fighters Study: (n=39) (Galetta et al., 2011)
         1. Learning effects
         2. Post-fight K-D scores correlated with post-fight Military Acute Concussion Evaluation (MACE) scores
         3. Worsening of K-D score by >5 sec noted only in subjects with head trauma
      ii. Collegiate Cohort Prospective Study: (n=219) (Galetta et al., 2011)
          1. Learning effects
          2. Worsening of K-D score by 5.9 sec (avg) in concussed athletes
          3. Exhaustion trial of basketball team (n=18) after 2 hour scrimmage showed average improvement of K-D time, K-D test robust to fatigue.
      iii. New Zealand Amateur Rugby Pilot study: (n=50) (King et al., 2012)
           1. Post-game K-D testing revealed 2 incidental concussions neither witnessed nor reported during the game
      iv. New Zealand Amateur Rugby Study: (n=37) (King et al., 2013)
          1. 5 witnessed concussions, 17 un-witnessed concussions
          2. By incorporating the K-D test as part of the post-match assessment of players concussive injuries were identified that may have previously gone unnoticed or unmonitored.
      v. NHL: Saccades and Memory (Galetta M et al., 2013)
         1. 2 concussions: worse on KD, no change on SAC
         2. DLPFC association between saccadic function and immediate memory
      vi. On-Going research:
         1. Collegiate (UF, pending publication)
         2. Youth studies (Mayo Clinic, Midwestern Univ, etc.)

3. Management
   a. Return to play vs. return to school
   b. Saccadic/Vestibular training/rehabilitation
   c. Concussion Prevention strategies
References:
20. Milka M. Reports of Concussions from Youth Sports Rise Along with Awareness of the Problem. JAMA. 2010;204:1775-76.