In a World of Pandemics, the Silent Epidemic Remains

EKU ATHLETIC TRAINING

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EKU Objectives

- **Effects** — Identify concerns and long-term implications of a "mild" traumatic brain injury.
- **Acute Care** — Will distinguish when to best use the principles of rest and/or activity in the acute management of concussions.
- **Sub-types** — Match clinical interventions based on the clinical presentation and "sub-type" of the symptoms

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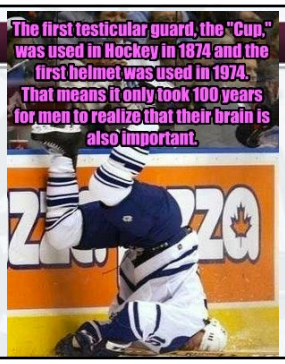

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Defining "Concussion"

"…a traumatic brain injury induced by biomechanical forces

1. Results from either direct or indirect force
2. Typically rapid onset, short-lived impairment, resolves spontaneously
3. Acute symptoms reflect a functional deficit rather than a structural injury
   - Normal structural neuroimaging studies
4. Large range of symptoms that may or may not involve loss of consciousness. Resolution typically follows a sequential course but post-concussive symptoms may be prolonged (small %).

- McCrory, *Br J Sports Med*, 2018

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Post-Concussion Syndrome

- Rates vary based on classification criteria
  - 6.3% of mTBI result in PCS (individual methods identify as much as 38.7%) (Voormolen, DC, et al. *J Neurotrauma,* 2017)
  - 45.1% of general population experience PCS-like symptoms (Voormolen, DC, et al. *Brain Inj,* 2019)

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CTE & Other Long-term Consequences

- CTE data similar to PCS
  - Diagnostic criteria unclear
  - Prevalence difficult to assess
  - Live detection still not possible
- Depression
- Cognitive deficits
- Risk of suicide

- Manley, G. *Br J Sports Med*, 2018

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EKU Traditional Acute Treatment

- Remove, Rest, Recovery
- Gradual Return to Participation Protocol

TABLE 1. Graduated Return to Play Protocol

Rehabilitation Stage	Functional Exercise at Each Stage of Rehabilitation	Objective of Each Stage
1. No activity	Complete physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity <70% MPHR; no resistance training	Increase HR
3. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer; no head impact activities	Add movement
4. Non-contact training drills	Progression to more complex training drills, eg, passing drills in football and ice hockey; may start progressive resistance training	Exercise, coordination, and cognitive load
5. Full contact practice	Following medical clearance, participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6. Return to play	Normal game play	

~ McCrory, *Br J Sports Med*, 2018

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EKU Published Guidelines Recommendations for Rest & Activity

American Academy of Pediatrics (2010)	• Discourage activities that require concentration and attention; • Withhold physical activity until asymptomatic • Cognitive rest, including absence from school, shortening school day, reduction of workload, allowance of more time
NATA (2014)	• Avoid physical activity and limit cognitive activity to not exacerbate concussion symptoms • Activities of daily living that do not exacerbate symptoms may be beneficial and allowed • Temporary academic accommodations should be allowed • Exertion should not begin until patient no longer reports symptoms, has normal clinical examination, and has normal neurocognitive functioning/motor; exercise progression
NCAA (2013)	• Physical and cognitive rest until the acute symptoms resolve • Some athletes may require academic accommodations such as reduced workload, extended test-taking time, days off or shortened day
CISG (2017)	• Rest during the acute phase (24–48 hours) • Gradual progression of physical and cognitive activity staying below symptom-exacerbation thresholds • Activity level should not bring on or worsen symptoms • Avoid vigorous exertion while recovering

~Moran, RN. Presentation (2022)

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Why rest?

Theory
1) ↓ risk of subsequent injury
2) ↓ energy diversion

Supporting Evidence:
- Increased activity ↓ cognitive ability (rats) (Leddy, et al., 2016)
- Early return to activity ↑ concussion symptom severity (Leddy, et al., 2016)
- ↑ excessive cognitive activity exacerbates symptoms and ↑ recovery time (Leddy, et al., 2016)
- Immediate removal may ↓ symptom severity (Asken et al., 2018)
- Continued play following concussive injury = 8x more likely to have prolonged symptoms >21 days (Elbin et al., 2016)

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Activity

However…
- Symptoms can come from non-brain related sources (Leddy, et al., 2016)
- Compliance with physical and cognitive rest associated with slower recovery (Moor et al., 2015).
- Complete rest ≥3 days shows no benefit (Leddy, et al., 2016)

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Activity

Furthermore…
- ↓ activity for athletes = ↑ depression, anxiety, chronic fatigue, pain disorders, PTSD, and ↓ self-esteem (Broglio, et al. 2015; Leddy, et al., 2016)

"Humans do not respond well to removal from their social and physical environments" (Leddy, et al., 2016)

- Physical activity within 7 days decreases likelihood of PCS at 28 days in adolescents (Grool, et al.)

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Caveats to Activity

- Children and adolescents might need more rest
- Uncontrolled or forced activity = bad, voluntary may enhance recovery (animal models)
- Exercise must not exacerbate symptoms
- No return-to-sport till completed graded activity asymptomatic

~ Leddy, et al., *Phys Med Rehabil Clin N Am*, 2016

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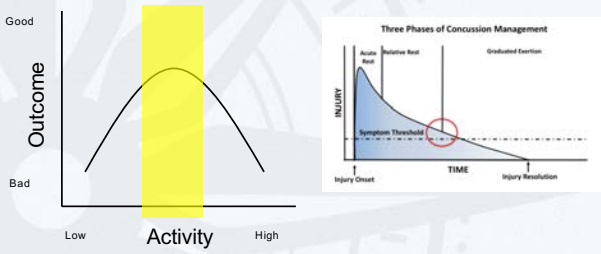
Activity Guidelines



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Graduated Return-to-Sport

Table 1 Graduated return-to-sport (RTS) strategy

Stage	Aim	Activity	Goal of each step
1	Symptom-limited activity	Daily activities that do not provoke symptoms	Gradual reintroduction of work/school activities
2	Light aerobic exercise	Walking or stationary cycling at slow to medium pace. No resistance training	Increase heart rate
3	Sport-specific exercise	Running or skating drills. No head impact activities	Add movement
4	Non-contact training drills	Harder training drills, eg, passing drills. May start progressive resistance training	Exercise, coordination and increased thinking
5	Full contact practice	Following medical clearance, participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6	Return to sport	Normal game play	

NOTE: An initial period of 24–48 hours of both relative physical rest and cognitive rest is recommended before beginning the RTS progression.
There should be at least 24 hours (or longer) for each step of the progression. If any symptoms worsen during exercise, the athlete should go back to the previous step.
Resistance training should be added only in the later stages (stage 3 or 4 at the earliest). If symptoms are persistent (eg, more than 10–14 days in adults or more than 1 month in children), the athlete should be referred to a healthcare professional who is an expert in the management of concussion.

~ McCrory, *Br J Sports Med*, 2018

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Return to Learn Considerations

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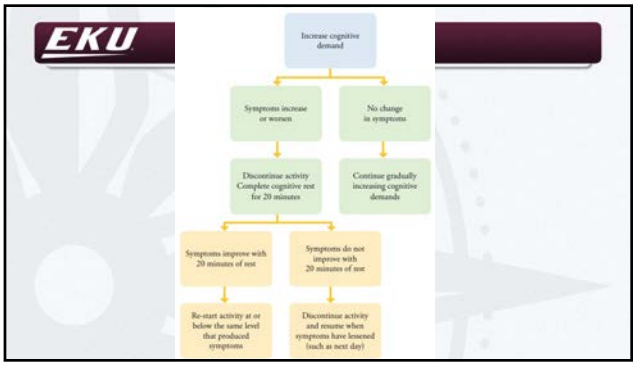

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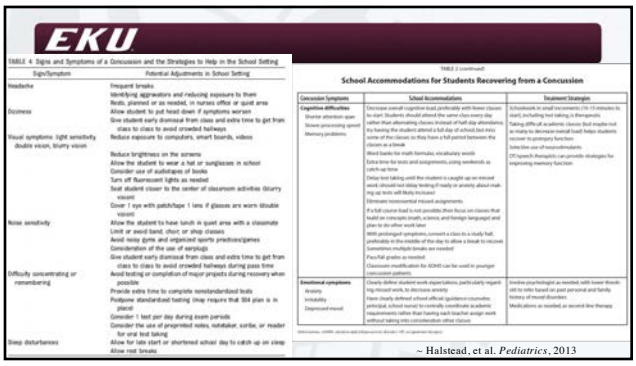

TABLE 4 Signs and Symptoms of a Concussion and the Strategies to Help in the School Setting

Signs/Symptom	Potential Adjustments in School Setting
Headache	Frequent breaks Identifying aggravators and reducing exposure to them
Dizziness	Reads, planned or as needed, in nurses office or quiet area Allow student to put head down if symptoms worsen Give student early dismissal from class and extra time to get from class to class to avoid crowded hallways
Visual symptoms: light sensitivity, double vision, blurry vision	Reduce exposure to computers, smart boards, videos Reduce brightness on the screens Allow the student to wear a hat or sunglasses in school Consider use of audiotapes of books Turn off fluorescent lights as needed Seat student closer to the center of classroom activities (blurry vision) Cover 1 eye with patch/tape 1 lens if glasses are worn (double vision)
Noise sensitivity	Allow the student to have lunch in quiet area with a classmate Limit or avoid band, choir, or shop classes Avoid noisy gyms and organized sports practices/games Consideration of the use of earplugs Give student early dismissal from class and extra time to get from class to class to avoid crowded hallways during pass time
Difficulty concentrating or remembering	Avoid testing or completion of major projects during recovery when possible Provide extra time to complete nonstandardized tests Postpone standardized testing (may require that 504 plan is in place) Consider 1 test per day during exam periods Consider the use of preprinted notes, notetaker, scribe, or reader for oral test taking
Sleep disturbances	Allow for late start or shortened school day to catch up on sleep Allow rest breaks

TABLE 2 (continued)

School Accommodations for Students Recovering from a Concussion

Concussion Symptoms	School Accommodations	Treatment Strategies
Cognitive difficulties: Shorter attention span Slower processing speed Memory problems	Decrease overall cognitive load preferably with fewer classes to start. Students should attend the same class every day rather than alternating classes. Instead of half-day attendance, try having the student attend a full day of school, but miss some of the classes so they have a full period between the classes as a break. Word banks for math formulas, vocabulary words Extra time for tests and assignments, using weekends as catch-up time Delay test taking until the student is caught up on missed work (should not delay testing if ready or anxiety about making up tests will likely increase) Eliminate nonessential missed assignments. If a full course load is not possible, then focus on classes that build on concepts (math, science, and foreign language) and plan to do other work later With prolonged symptoms, convert a class to a study hall, preferably in the middle of the day to allow a break to recover. Sometimes multiple breaks are needed Pass/fail grades as needed Classroom modification for ADHD can be used in younger concussion patients	Schedule work in small increments (10–15 minutes to start), including test taking, in therapeutic Taking difficult or academic classes (but maybe not as many to decrease overall load) helps students recover to premorbid function Selective use of neurostimulants OT/speech therapists can provide strategies for improving memory function
Emotional symptoms: Anxiety Irritability Depressed mood	Clearly define student work expectations, participate regarding missed work, to decrease anxiety Have clearly defined school official (guidance counselor, principal, school nurse) to centrally coordinate academic requirements rather than having each teacher assign work without taking into consideration other classes	Involve psychologist as needed, with lower threshold to refer based on past personal and family history of mood disorders Medications as needed, as second-line therapy

~ Halstead, et al. *Pediatrics*, 2013

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Rehabilitation – Following Clinical Trajectories

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~Moran (2022).

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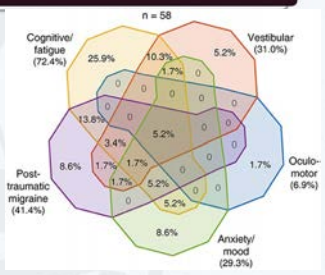
TABLE 1 | Prevalence of moderate-to-severe symptom identification.

	Prevalence (%)		p*
	Concussed (N = 89)	Baseline (N = 3068)	
Cognitive-fatigue	47.2	11.5	<0.001
Vestibular	20.2	2.4	<0.001
Oculomotor	4.5	1.5	0.042
Anxiety/mood	19.1	9.5	0.006
Migraine	27.0	1.4	<0.001
Sleep	31.5	8.4	<0.001

*as determined by a binomial test.



Maruta et al., 2018

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Cognitive / Fatigue

- Definition: cognitive difficulties
  - ↓ concentration
  - ↓ multi-tasking
  - ↑ distractibility

- Symptom Recognition:
  - Feeling "in a fog", feeling slowed down, difficulty concentrating
  - ↓ energy levels/fatigue
  - Non-specific headache that continually worsens

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Cognitive/Fatigue

- Clinical Presentation:
  - Elevated cognitive-related symptoms on SCAT-5
  - Mild ↓ in memory and processing speed on neurocognition
  - Non-provoking vestibular/ocular motor screening
  - Normal balance and postural stability

- Management:
  - Reduce physical and cognitive demands
  - Brief academic/work accommodations
  - Regulate diet & sleep schedule
  - Cognitive re-training when asymptomatic

~ Kontos et al., 2019; Broglio et al., 2015

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Post-Traumatic Migraine

- Definition: chronic headache & migraines

- Symptom Recognition:
  - Intermittent headaches
  - Pulsating headache with nausea or photophobia
  - Symptoms exacerbated with stress or anxiety
- Clinical Presentation:
  - Elevated headache, pressure in head, sensitivity to light/noise symptoms on SCAT5
  - ↓ visual or verbal memory on neurocognition
  - Minor provocation of HA on vestibular/ocular motor screening
  - Normal balance and postural stability

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Post-Traumatic Migraine

- Management:
  - Behavioral regulation
  - Pharmacological interventions
  - Increased cardiovascular activity/exertion protocol
    - *SUBSYMPTOM THRESHOLD!*

~ Kontos et al., 2019; Broglio et al., 2015

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Vestibular

Symptoms
- Dizziness, blurred/unstable vision, discomfort in busy environments, nausea

Impairments
- Benign paroxysmal positional vertigo (BPPV) – canalith repositioning
- Vestibulo-ocular reflex impairment – gaze stability
- Visual motion sensitivity
- Balance dysfunction
- Exercise-induced dizziness

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Vestibular

- Definition: impairments of the vestibular system affecting balance and vision with head movement

- Symptom Recognition:
  - HA, dizziness, nausea, fogginess
  - Loss of balance and proprioception
  - Overstimulation in complex environments
  - Provoking symptoms with head movement

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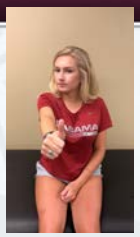
EKU Vestibular

- Clinical Presentation:
  - HA, dizziness, fogginess symptoms on SCAT5
  - ↓ balance and postural stability
    - Major sensory interaction and sway impairments
  - Provocation with vestibular ocular reflex testing (VOR & VMS)
  - Exercise-induced dizziness



~ Kontos et al., 2019; Broglio et al., 2015

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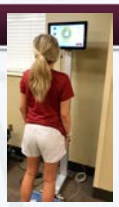
- Management:
  - Multifaceted because of vestibular-spinal & vestibular-ocular motor
    - Vestibular-spinal:
      - Maintain or restore balance and postural stability
      - Improve sensory interaction
    - Vestibular-ocular:
      - VOR: Gaze stability exercises
        - Consider speed, duration, complexity of background
      - VMS: Gradual exposure to provocative stimuli
  - Exercise: progress, manipulate afferent input, dual task



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- Definition: suffering from excessive worry or lack of control over thoughts
- Symptom Recognition:
  - Psychological symptoms (anxiety, depressions, mood changes, etc.)
  - Sleep disturbances/panic attacks
  - Feeling overwhelmed

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Anxiety/Mood

- Clinical Presentation:
  - Emotional-related symptoms on SCAT5
    - Compare to medical history of psychiatric disorders & medications!
  - Normal neurocognition
  - Normal balance and postural stability
  - Non-provoking vestibular/ocular motor screening
- Management:
  - Psychosocial approaches
  - Exertional therapy for emotional release
  - Pharmacological intervention
  - Regulated sleep/nap schedule
  - Athlete identity/isolation reassurance

More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6

~ Kontos et al., 2019; Broglio et al., 2015

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Ocular

- Definition: disruption in vision and tracking
- Symptom Recognition:
  - Frontal headaches or pressure behind eyes
  - Difficulty with vision and screens
  - Difficulty tracking objects
  - Eye strain
- Clinical Presentation:
  - Blurry vision on SCAT5
  - Provoking ocular motor tasks
    - Smooth pursuits & saccades
  - ↓ near point of convergence
  - Accommodation insufficiency
  - Nystagmus

~ Kontos et al., 2019; Broglio et al., 2015

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Ocular

- Management:
  - Vision therapy
  - Brock string/pencil pushups for convergence insufficiency
  - Implement dual task vision exercises with balance/vestibular activities

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Cervical

- Definition: cervical tightness, spasm, or pathologies secondary to SRC
- Symptom Recognition:
  - Occipital headaches, neck pain
- Clinical Presentation:
  - Neck pain on SCAT5
  - Decreased cervical ROM
  - "Lazy effort" vestibular/ocular motor screening
  - Normal balance and postural stability

~ Kontos et al., 2019; Broglio et al., 2015

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Cervical

- Management:
  - Stretching/ROM exercises
  - Cervical/soft tissue mobilizations
  - Pharmacological interventions (NSAIDs, muscle relaxants)
  - Strengthening once asymptomatic (deep cervical)

~ Kontos et al., 2019; Broglio et al., 2015; Grabowski et al., 2017

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Buffalo Concussion Treadmill Test

Table 2.
Differential diagnosis of PCD using the BCTT and the physical examination.

Diagnosis	Physiologic PCD	Cervicogenic PCD	Migraine PCD	Affective PCD	Vestibular/Ocular PCD
BCTT response	Distinct submaximal symptom-limited threshold characterized by complaints of sudden increase in lightheadedness, headache, head pressure, or "fullness" of the head.	No distinct symptom-limited threshold. Able to exercise to exhaustion. Posterior headache that improves early in exercise but often returns near exhaustion.	BCTT not performed if migraine present. If migraine not present, there is no distinct symptom-limited threshold. Able to exercise to exhaustion.	No distinct symptom-limited threshold. Able to exercise to exhaustion. Mood usually improves with exercise testing.	No distinct symptom-limited threshold. Able to exercise to exhaustion. Symptoms are usually visual (blurred vision, difficulty with focusing) or mild lightheadedness. Vertigo typically is not reported during the test.
Physical exam	May have orthostatic drop in BP and or rise in HR.	Cervical muscle tenderness and/or spasm, reduced motion, altered cervical proprioception, suboccipital tenderness	Exam usually normal when not symptomatic. May have photosensitivity.	May have flat or depressed affect.	Discomfort (and sometimes nystagmus) with ocular smooth pursuits and saccades, abnormal ocular convergence (>6 cm), abnormal VOR,* positive Romberg and abnormal tandem gait.

* VOR, vestibulo-ocular reflex; BCTT, Buffalo Concussion Treadmill Test; PCD, post concussion disorders.

~ Leddy, Willer, *Curr Sports Med Rep*, 2013

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Overall Rehabilitation Guidelines

Should consist of 3 core components:
- sub-symptom cardiovascular exercise
- Vestibular/oculomotor therapeutic exercise
- Cervicothoracic manual therapy and therapeutic exercise

Education is a key element as well

75% of patients had either vestibular, oculomotor, or cervicothoracic dysfunction

~ Grabowski et al., 2017

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Outside the Box Approach

- TBI (possibly mTBI) leads to pituitary dysfunction and ↓ growth hormone secretion
- GH supplementation following TBI in deficient individuals improves outcomes
- GH supplementation controversial, however, endogenous production ↑ resistance training
- BFR therapy increases GH secretion

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Need for Continuity in Care

- Time to drop the barriers, recognize our strengths and employ these for the patient

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