



## Prevention and Anticipatory Guidance

- Consider pre-participation online testing/evaluation if not done by team
- Proactive nourishing the brain nourishing/BDNF augmenting tips
  - Anti-inflammatory, gluten- and casein-free diet rich in medium chain triglycerides (MCTs)
  - Introduce ketogenic concept as a brain health supporter
  - Supplements to consider:
    - Omegas
    - Vitamin B6
    - NAC
- Educate patient and family
  - A “wait and see” approach does a disservice to the brain.
  - It is better to be proactive and aggressively reactive in containing a process that easily becomes chronic and progressive.
  - Support for the brain generally needs to be long-term, as much as two years.
- Symptoms for family members to monitor
  - Irritability
  - Persistent headache
  - Photophobia
  - Poor judgment
  - Change in sleep patterns

## Mechanisms of Injury

- Loss of consciousness (LOC) does not indicate severity of injury.
- Classic concussion: caused by coup–contrecoup or rapid acceleration/ deceleration leading to gross inflammation, hematoma, and perhaps increased intracranial pressure (ICP).
- Diffuse Axonal Injury (DAI)/neuronal shear:
  - Repeated smaller impact with recurring neuronal shear, with or without accompanying vascular injury: This is probably a much more significant contributor to chronic traumatic encephalopathy (CTE).
  - Grey matter (primarily unmyelinated cell bodies) is less dense than white matter (primarily myelinated axons). With impact, different densities travel at different speeds producing shear forces and DAI.
  - Process may perpetuate for up to 24 months, so long-term brain support is needed.

## Processes to Be Mitigated and Healed in brain injury

- Neuronal shear may stretch axon or disconnect it from neuronal cell body
- Injured axon degenerates releasing toxic levels of debris, demyelination begins
  - Neurotransmitters, excitatory glutamate
  - Inflammatory chemokines and cytokines
  - ROS
  - Proteases
- Bleeding– macro and/or microscopic
- Domino effect: death of surrounding neurons
- Inflammation
  - Macroscopically can increase ICP and restrict blood flow to brain
  - Microscopically is an insidious process that chokes off vascular delivery of nutrients and oxygen to damaged cells, leading to anaerobic metabolism, lactate buildup and cell death
- Microglial activation: “vultures” phagocytosing the debris produced but also promoting and prolonging inflammatory response with release of  $\text{TNF}\alpha$  and  $\text{IL-1}\beta$
- Scarring: Inflammatory response continues as the cell body dies, and as communication between cells stops, the process cascades, and finally, astrocytes come in and try to seal off the death process, making a sort of scar. This makes it much harder to repair the axons.
- Hypoxia: non-ischemic
- Hypermetabolic state, especially hyperglycemia

## Assessment

- Morning or day after (beyond the sideline):
  - Light sensitivity
  - Headache
  - Nausea/vomiting
  - Irritability
  - Loss of purposeful and appropriate behavior
  - Online test/evaluation:
    - ImPACT: widely used; minimum purchase, free training
    - HeadCheck: more involved app for use by teams or neurologist
    - XLNT Brain Sport: comprehensive evaluation and monitoring software/app

- Lab testing: there are no readily available and reliable markers to monitor brain injury at this time, although S100B and GFAP show potential value
- Imaging may provide false sense of security as microscopic bleeding and injury will not show acutely
  - Inadequate assessment of the extent of damage
  - Assesses gross changes, but not microscopic
  - Unlikely to impact management in the non-hospitalized patient
- Weeks and months later:
  - Impaired long-term memory
  - Reduced problem solving ability
  - Reduced social inhibition
  - Attention and perception problems

## Considerations in Management

Individual patients will have greater or lesser needs in each area. Needs of the brain are much higher (doubled or more) and may continue for up to two years. IV delivery, where and when feasible, may be best.

In regards to dosing: Consider your patient—size; baseline status in terms of inflammation and oxidative stress; genetic vulnerability; experience with supplements; potential for delivering some supplements IV; patient response; and financial resources. The injured brain may require double or more the dose it normally requires.

- Mitigate inflammation/immune response:
  - Mild hyperbarics: As many hours as the patient can get.
  - Omega 3 fatty acids: minimum 3,000 mg/day, up to as much as 10,000 mg daily for weeks to months
  - Curcumin with bioperine: 500 mg twice daily, increasing dose if tolerated and helpful
  - Deglycyrrhizinated licorice root (DGL): 200 mg daily, increasing dose if tolerated and helpful
  - Probiotics: 100 billion organisms, dairy free, taken in evening, and increasing liberally if tolerated and helpful; probiotics promote competence of the immune system.
  - Anti-inflammatory foods: potentially increasing calories, especially from protein and healthy fats
- Provide mitochondrial support
  - Co-Q 10: 100 mg twice daily, increasing liberally if tolerated
  - Medium chain triglycerides (MCTs): best to get from food sources (e.g., coconut oil, nuts, seeds)
  - Carnitine: generally 100 mg/kg/day with a maximum of 3 grams daily, as long as sleep is not disrupted and the patient doesn't begin to smell "fishy"
- Provide glutathione and reduce oxidative stress; increase antioxidants:
  - Glutathione: minimum 300 mg, increasing significantly to as much as several grams given twice daily if tolerated

- and helpful with symptoms
- NAC: minimum 300 increasing to 1000 or 1500 mg, if tolerated without sleep disruption or irritability and if helpful with symptoms
- Resveratrol: 100 to 1500 mg
- Methyl B-12: oral forms generally begin at 5000 mcg, and increasing doses can be used
- Provide multifaceted neurologic support:
  - Vitamin B6: minimum 50 mg daily, increasing if tolerated and helpful
  - Combination support (e.g., Neurolink), if well tolerated: dosing as directed, up to 6 caps daily
  - GABA: helpful neurologically when the BBB is disrupted; 250 mg twice daily to as much as 1000 mg three times daily is often used in patients without acute brain injury; more may be useful in brain-injured patients
  - CBD: not only loads endocannabinoid receptors, but is also a promotor of the GABA A receptor; 2 to 80 mg per dose given 1-3 times daily may be helpful
  - Gingko: 120 to 600 mg daily
  - Ginseng: 250 to 500 mg; higher doses may not be helpful
  - Magnesium: minimum 200 mg, increasing if tolerated and helpful; the specific form of magnesium used will impact stools
  - Vitamin E: 200 IU and increasing dose, with careful attention to the potential for bleeding as a side effect
  - Phosphatidyl serine: 200 mg twice daily, and increasing if helpful; threshold effect at 400 mg
- Acupuncture

## Returning to Play

- Must remain symptom free
- Rest brain and eyes, especially from electronics
- Activities of daily living
- Begin with simple cardio: walking, stationary bike, etc.
- Sport-specific, non-contact drills
- Sport-specific, higher brain demand drills
- Regular practice
- Return to regular activities

## Monitoring Long-Term Risks

- PTSD
- Depression/anxiety
- Learning struggles

