Postconcussion Syndrome

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Disclosures

- I have no financial disclosures
- I may discuss off-label use of medications

Objectives

- Review typical postconcussion syndrome course and recovery
- Contrast to atypical postconcussion recovery
- Return to school and play
- Overview of risk factors for prolonged postconcussion recovery
- Therapy for post-concussive symptoms

Definitions

- Concussion (AAP): "A concussion is a type of mild traumatic brain injury (mTBI) caused by a bump, blow, or jolt to the head or by a hit to the body that causes the head and brain to move rapidly back and forth. This sudden movement can cause the brain to move or twist in the skull, creating chemical changes in the brain and sometimes stretching and damaging brain cells."
  - Can occur with or without LOC
  - Variable severity and degree of injury (30-80% can have symptoms)
  - Usually resolves within 10-14 days

Nunneley, CM 2022, AAP Concussion

Relevance

- Of the nearly 3.8 million sports related concussions yearly, the majority are in children and adolescents
- In kids and adults less than half of people will seek medical care for symptoms

Sport	Concussions per 1000 AEs
Boys' tackle football	0.54–0.94
Girls' soccer	0.30–0.73
Boys' lacrosse	0.30–0.67
Boys' ice hockey	0.54–0.62
Boys' wrestling	0.17–0.58
Girls' lacrosse	0.20–0.55
Girls' field hockey	0.10–0.44
Girls' basketball	0.16–0.44
Boys' soccer	0.17–0.44
Girls' softball	0.10–0.36
Boys' basketball	0.07–0.25
Girls' volleyball	0.05–0.25
Cheerleading	0.06–0.22
Boys' baseball	0.04–0.14
Girls' gymnastics	0.07
Boys' and girls' track and/or field	0.02
Boys' and girls' swimming and/or diving	0.01–0.02

Challenges to Diagnosis

- Symptoms are often "subjective" – child has to report
- Some children will intentionally hide or not report
  - 80% of rugby players omitted/downplayed symptoms before returning to play
  - In 2013 46% said they would not report (better than 70% in 2002)

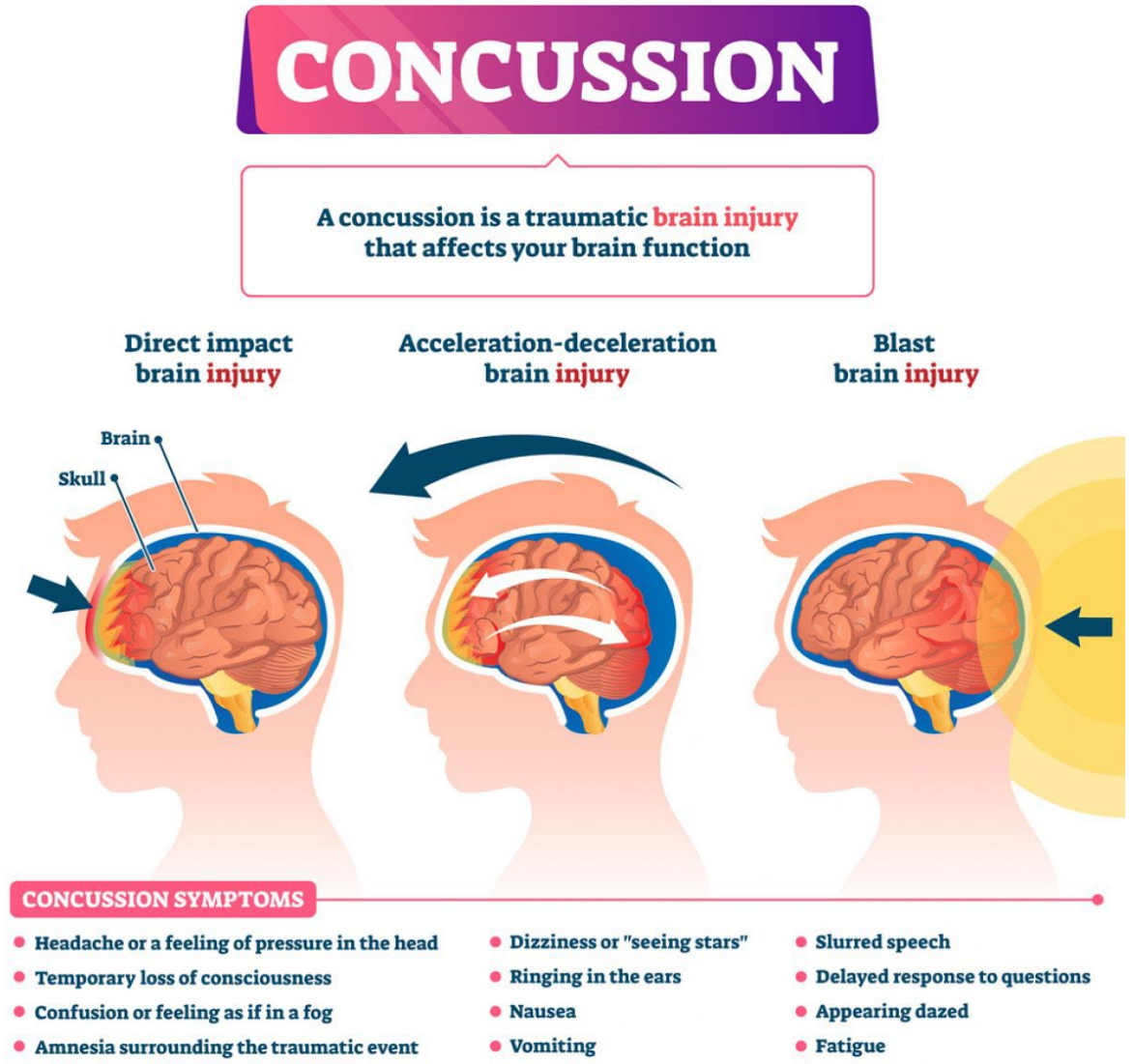
Tools to Help

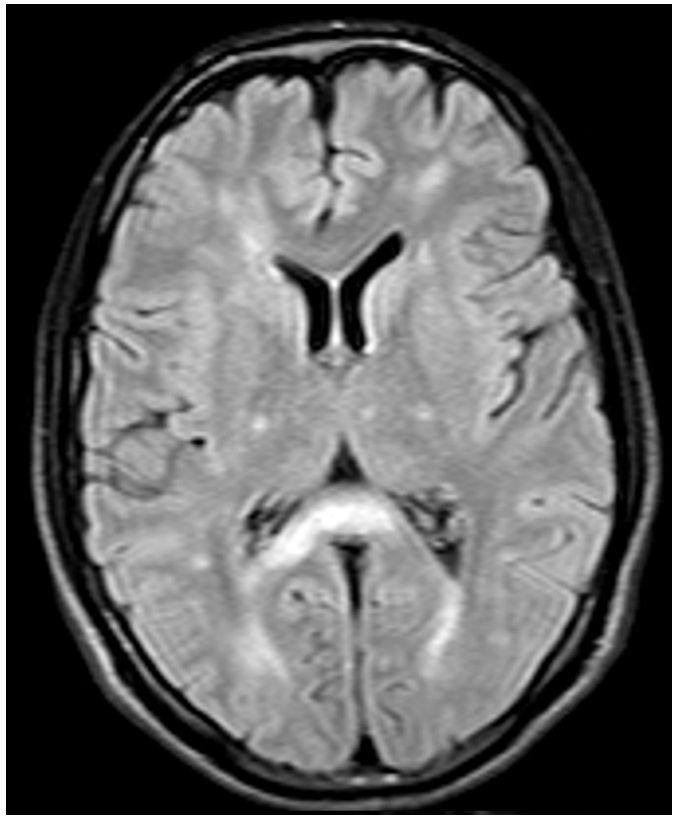
- ACE – Acute Concussion Evaluation
  - In office tool for PCP
- SCAT5 – Standardized Concussion Assessment Tool
  - Used by trainers and medical staff
- ImPACT – Immediate Postconcussion Assessment and Cognitive Test
  - Most commonly used by athletic trainers
- MACE – Military Concussion Evaluation

Symptoms of Concussion

- Variable in every individual
- Doesn't have to be direct blow
- Signs per 2014 review
  - Disorientation/confusion immediate, short term
  - Imbalance within 24 hours
  - Slow reaction time, impaired memory and verbal learning within 2 days

Image: Mobile Physiotherapy Clinic





Diffuse Axonal Injury

American Journal of NeuroRadiology 2015

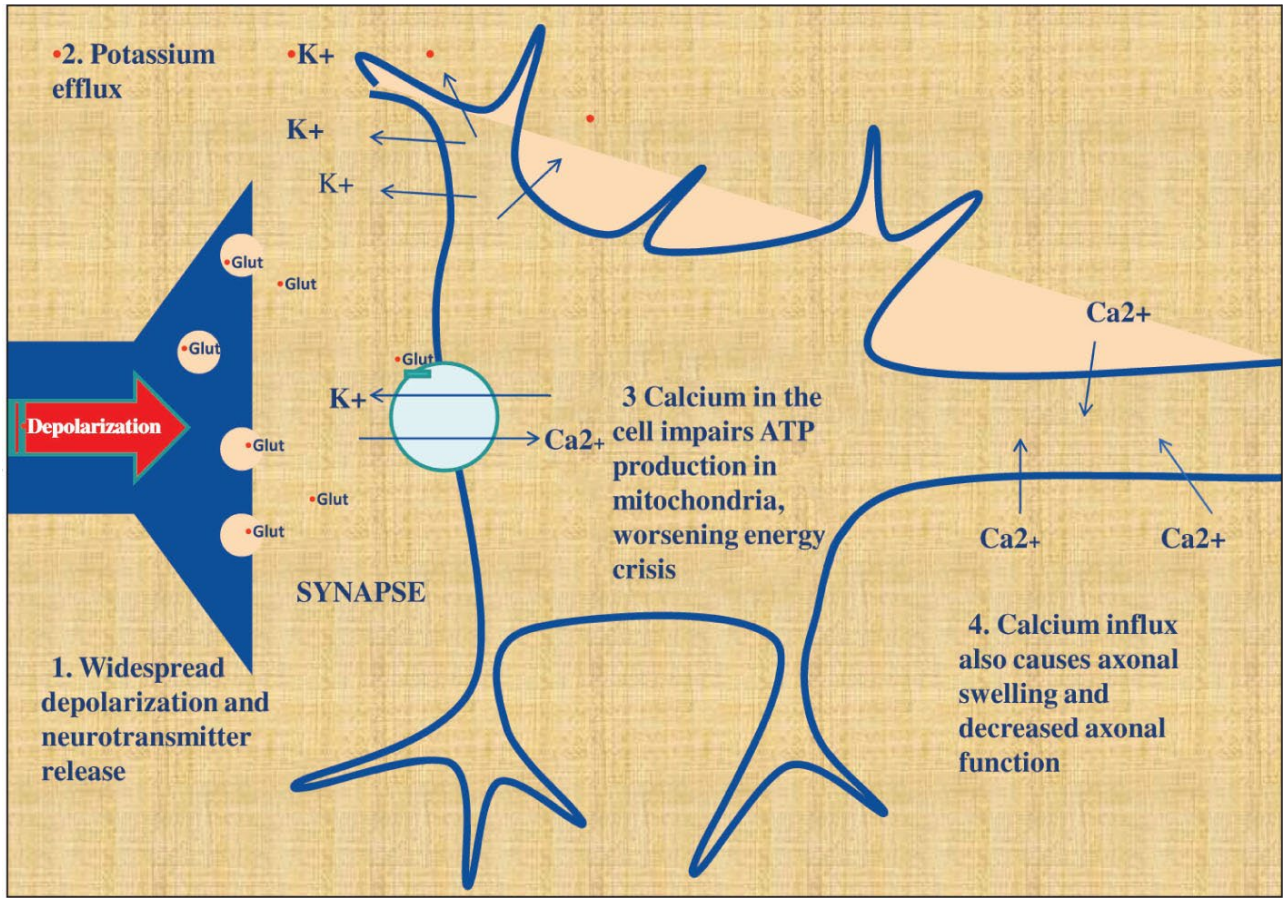
Pathophysiology

- Thought to be down to the cellular level, so MRI/imaging often negative
- Axonal stretching -> transient ion disruption ->reduction in conduction velocity
- Changes in ion flux and neurotransmitter transmission up to 4 weeks later
- Blood flow reduced and energy metabolism altered due to the metabolic changes
- In severe cases, petechial hemorrhages and local edema seen associated with cell injury and death

Pathophysiology

- Potassium flows out, sodium and calcium flow in, preventing further depolarization to fire action potential
- Reduced glutamate (excitatory neurotransmitter) so less activity
- Cell upregulates pumps to restore homeostasis, reducing overall intracellular energy
- Calcium gets "stuck" in the mitochondria and impairs metabolism further, taking weeks to improve
- Can lead to apoptosis

https://journals.healio.com/doi/10.3928/00904481-20120827-12



Physical Rest

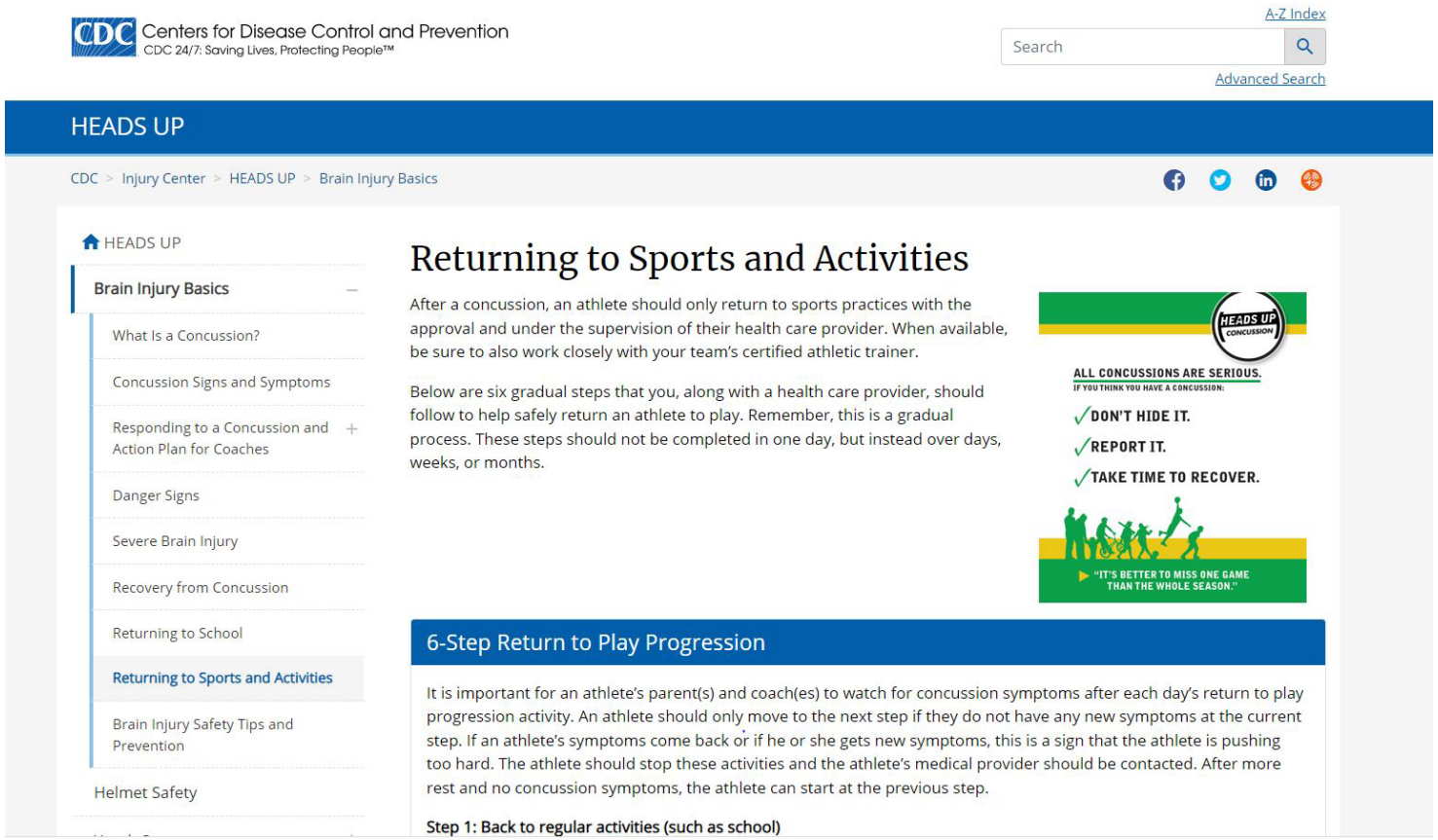
- Early limited exercise associated with more rapid recovery
  - Study of 100 adolescents who did sub-threshold aerobic exercise x 20 mins = better recovery times than those who did just stretching
    - Non-statistically significant trend towards lower PCS symptoms
  - Rapid return exacerbates symptoms
- Strict physical and cognitive rest prolonged symptoms
  - Persisted longer than 10 days in many individuals in another study
- Second injury after concussion also worsens symptoms
  - Second impact syndrome – within 1 week of injury

Second Impact Syndrome

- A second injury within 7-10 days of concussion
- Results in cerebrovascular dysfunction and cerebral edema
- Progresses to herniation -> death
- Nearly all cases recorded in those <20 years of age

HEADS UP

- Six steps to get back to sport
- Prerequisite is getting back to school!



HEADS UP Return to Play Protocol

Step 1: Back to regular activities (such as school)
Athlete is back to their regular activities (such as school).

Step 2: Light aerobic activity
Begin with light aerobic exercise only to increase an athlete's heart rate. This means about 5 to 10 minutes on an exercise bike, walking, or light jogging. No weight lifting at this point.

Step 3: Moderate activity
Continue with activities to increase an athlete's heart rate with body or head movement. This includes moderate jogging, brief running, moderate-intensity stationary biking, moderate-intensity weightlifting (less time and/or less weight from their typical routine).

Step 4: Heavy, non-contact activity
Add heavy non-contact physical activity, such as sprinting/running, high-intensity stationary biking, regular weightlifting routine, non-contact sport-specific drills (in 3 planes of movement).

Step 5: Practice & full contact
Young athlete may return to practice and full contact (if appropriate for the sport) in controlled practice.

Step 6: Competition
Young athlete may return to competition.

Cognitive Rest

- Those with limited symptoms can go back to activities as tolerated
  - Lots of screen time may prolong symptoms
  - Rest for 1-2 days may help with outcomes
  - Some experts say once 30 mins activity reached, ok to go back
  - Consider half days or limited activities to start

Cognitive Rest

- For persistent symptoms – looking for moderation
  - Some rest has helped speed recovery in small observational studies
  - Another study found that more prolonged strict restrictions increased rates of PCS
    - Reading, video games, screen time can exacerbate but should be undertaken gradually
    - May need some short-term accommodations
      - Rest/breaks for headaches, fatigue
      - Limited/lighter load
      - Reduce high-stakes testing
      - Extra time in passing period
      - Visual accommodations (sunglasses, audio books)
      - Quiet lunches (with classmate)

Returning to School

1. Rest

Your child should take it easy the first few days after the injury when symptoms are more severe.

- Early on, limit physical and thinking/remembering activities to avoid symptoms getting worse.
- Avoid activities that put your child at risk for another injury to the head and brain.
- Get a good night's sleep and take naps during the day as needed.

2. Light Activity

As your child starts to feel better, gradually return to regular (non-strenuous) activities.

- Find relaxing activities at home. Avoid activities that put your child at risk for another injury to the head and brain.
- Return to school gradually. If symptoms do not worsen during an activity, then this activity is OK for your child. If symptoms worsen, cut back on that activity until it is tolerated.
- Get maximum nighttime sleep. (Avoid screen time and loud music before bed, sleep in a dark room, and keep to a fixed bedtime and wake up schedule.)
- Reduce daytime naps or return to a regular daytime nap schedule (as appropriate for their age).

3. Moderate Activity

When symptoms are mild and nearly gone, your child can return to most regular activities.

- Help your child take breaks only if concussion symptoms worsen.
- Return to a regular school schedule.

4. Back to Regular Activity

Recovery from a concussion is when your child is able to do all of their regular activities without experiencing any symptoms.

Postconcussion Syndrome (PCS)

- "Postconcussion syndrome (PCS) refers to nonspecific neurologic, cognitive, and psychological symptoms that result from traumatic brain injury (TBI) and persist longer than the expected recovery period"
  - If symptoms last longer than 14 days, odds that it will linger >3 months
  - Only 10% of people have symptoms that linger and most resolve within a few months
    - Does not correlate well to severity of injury (LOC, imaging findings)
  - Approximately 15% of patients can still have symptoms at 1-year post-injury

Nunneley, CM 2022, AAP Concussion Guidelines

PCS Clinical Presentation

Nunnelly, CM 2022, AAP Concussion

- Linger for much longer than expected (>10-14 days)
- Symptoms include:
  - Headaches – migraine and tension type
  - Dizziness/vertigo
  - Impaired memory and concentration
  - Irritability/Low stress tolerance
  - Sleep disturbance
- Can also be associated with neck pain, phonophobia and paresthesia
  - NOT dermatomal or focal deficits

Cause?

- Apoptosis of cells
- Changes in expression of channels and ion pumps
- Behavioral Alteration

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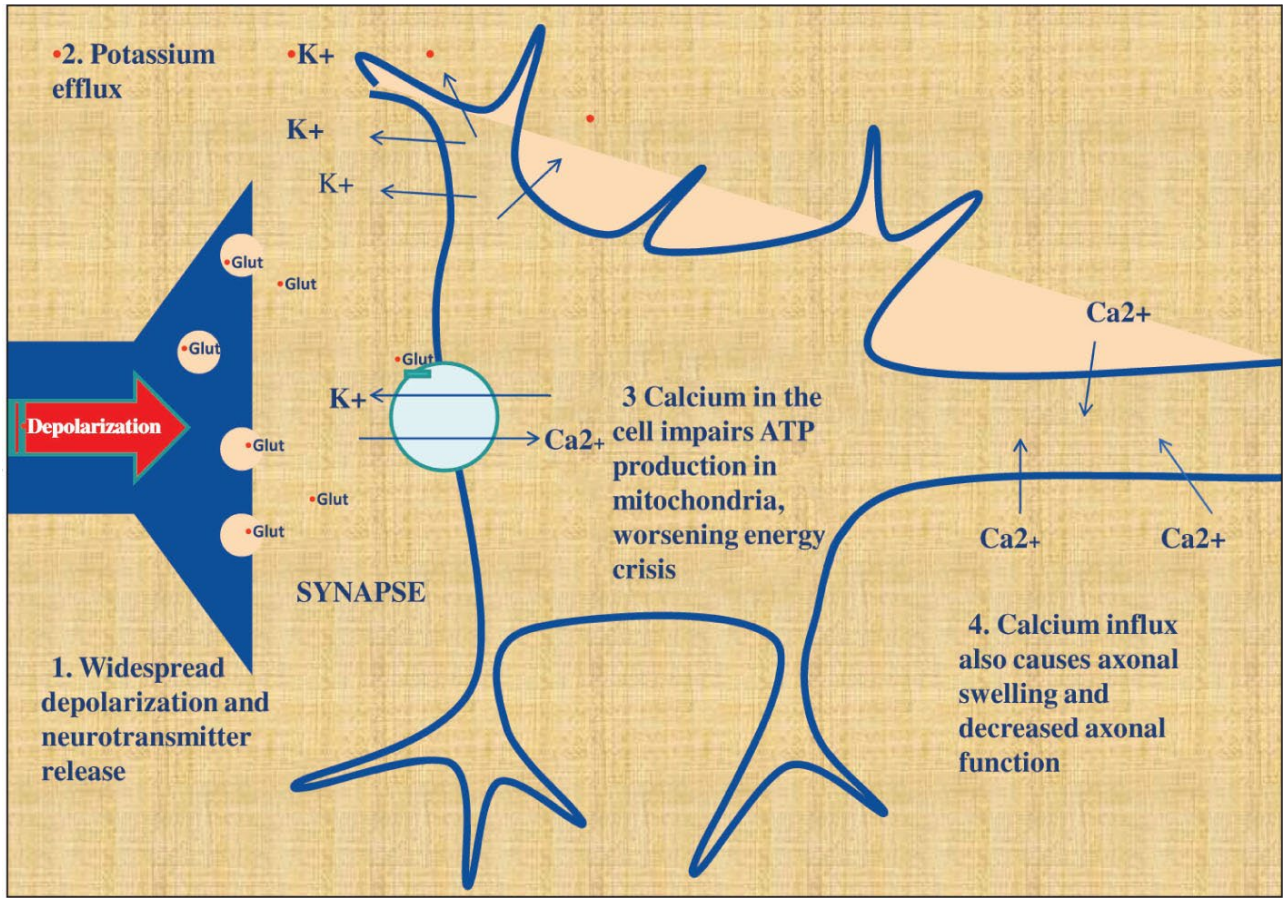

Complicating Diagnostic Factors

- Small but sometimes measurable deficits in concentration, language, memory, executive function
  - Similar to depression anxiety
- Psychogenic contribution (headache, dizziness, sleep impairment)
  - Improve with antidepressants in some studies
  - Worse in individuals with predispositions and comorbidities
    - Limited social support, poor coping, previous illness
- If CT normal, up to 30% of patients can still have MRI abnormalities
- PET/SPECT can show changes, but these changes similar to those with depression and migraine
- Small studies have suggested increased atrophy after injury, not well studied

Risk Factors for Persistent PCS

*Many from adults

- Prior headaches/TBI
  - More recent = higher risk
- Female sex (12 weeks vs 4 weeks)
- More severe symptoms at onset
- Vertigo/vestibular symptoms linger
- Premorbid conditions – migraine, depression
- Prior psychiatric illness
  - Anxiety in particular
- Ongoing litigation*
  - Studies conflict on this
  - Patients don't improve after finished
- Limited social support
- Low SES

Therapy Considerations – Non-Pharmacologic

- Time and regular follow up
- Early but graduated physical activity
  - Light aerobic activity helpful
  - OT/PT can help
- Cognitive Behavioral Therapy
  - Just like coping with any other illness
- Good sleep hygiene!

Therapy Considerations –Pharmacologic

Pharmacologic

- OTC's ok in short term, not long term
  - Medication overuse headache
- Amitriptyline common in post-traumatic headaches/tension headaches
  - May help with dizziness, insomnia and mood issues
- Propranolol is also effective, can cause lightheadedness
- Amantadine, particularly for sleep/wake disturbance
- Melatonin*
- Nausea – ondansetron

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