

# Concussion Management

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Until every child is well™



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# Objectives

- Define concussion
  - Underlying physiology, signs and symptoms
- Diagnosis of concussion
- Differential diagnosis
  - Signs and symptoms needing emergent evaluation
- Concussion management
- Short term and long term effects of concussion
- Talking to parents about concussion



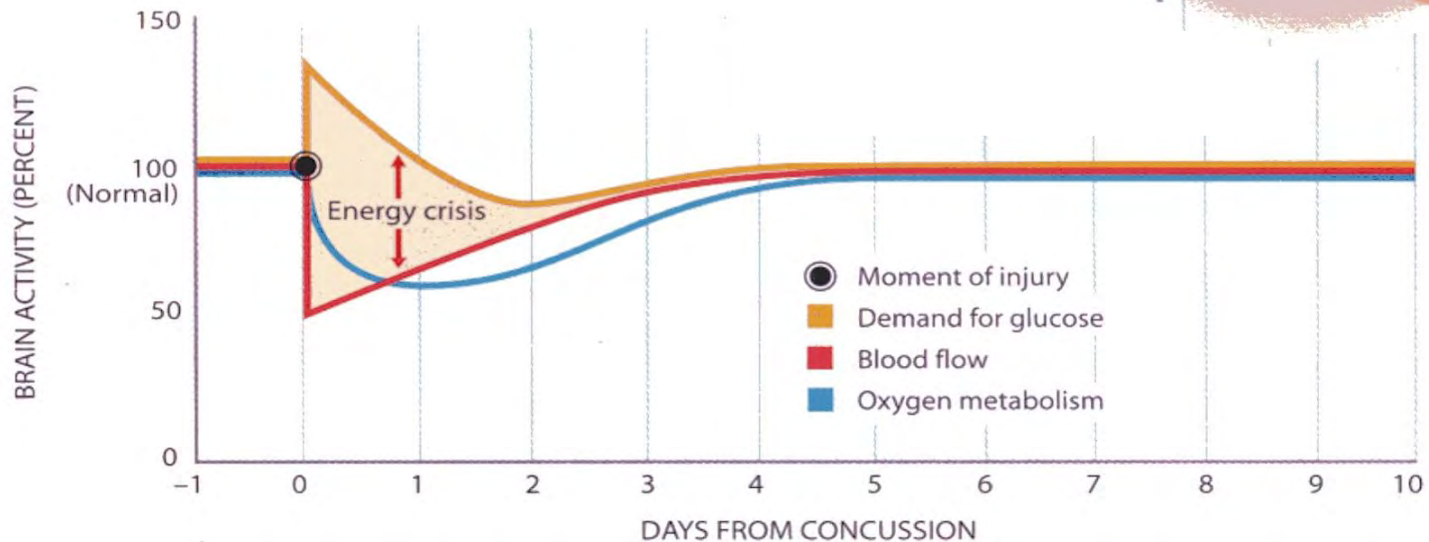
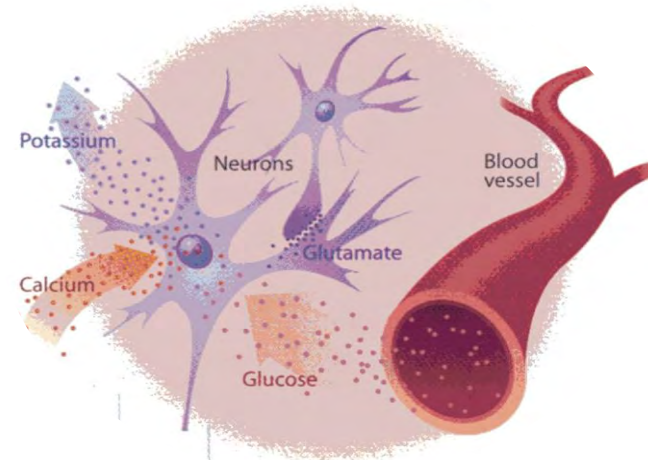
# Defining Concussion

- 4th International Conference on Concussion in Sport
  - 3<sup>rd</sup> conference eliminated grading scales
- Concussion: “complex pathophysiological process affecting the brain, induced by traumatic factors”  
***aka, trauma induced brain dysfunction***
  - Direct blow to head or “impulsive” force transmitted to head
  - Typically results in rapid onset of short-lived impairment of neurologic function that resolves spontaneously
  - May result in neuropathologic changes, but acute symptoms reflect a functional disturbance rather than a structural injury
  - **No abnormality on standard structural neuroimaging is seen in concussion**



# Pathophysiology

- Ion flux: efflux of  $K^+$ , influx of  $Ca^{2+}$ 
  - Depolarization – spreading depression
- Intracellular glucose delivery interrupted
- Decreased flow with increased demand
- Creates metabolic dysfunction



# Signs and Symptoms of Concussion

- Any cognitive symptoms after impact
  - May be collective number of hits versus single injury
- Immediate symptoms
  - **Loss of consciousness in 5% or fewer of cases!**
    - Increased risk of structural injury, but little effect on concussion course
  - Headache, drowsiness, confusion
  - Tinnitus, blurry vision, nystagmus
  - Slurred speech, change in performance
- Delayed symptoms – may be days later
  - Headaches, sleep disturbance, fatigue
  - Confusion, trouble concentrating/reading
  - Depression, anxiety
- ***Any suspicion of concussion requires immediate removal from play***



# Subjective Symptom Scale

	None	Mild		Moderate		Severe	
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck pain	0	1	2	3	4	5	6
Balance problems or dizziness	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Vision problems	0	1	2	3	4	5	6
Hearing problems / ringing	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Feeling "dinged" or "dazed"	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
More emotional than usual	0	1	2	3	4	5	6
Irritable	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	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
Trouble falling asleep	0	1	2	3	4	5	6
Sleeping more than usual	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Other: _____	0	1	2	3	4	5	6



# Making the Diagnosis – The Exam

- Impact site
  - Evidence of local trauma, contusion
  - General interaction – squinting, quiet, lying down
  - Responsiveness, mood, affect, speech patterns
- Cervical Evaluation
- Neurologic exam
  - CN II-XII, reflexes
  - Romberg, Finger-to-nose testing
  - Modified Balance Error Scoring System (BESS)
  - Strength to upper and lower extremities

# Differential Diagnosis

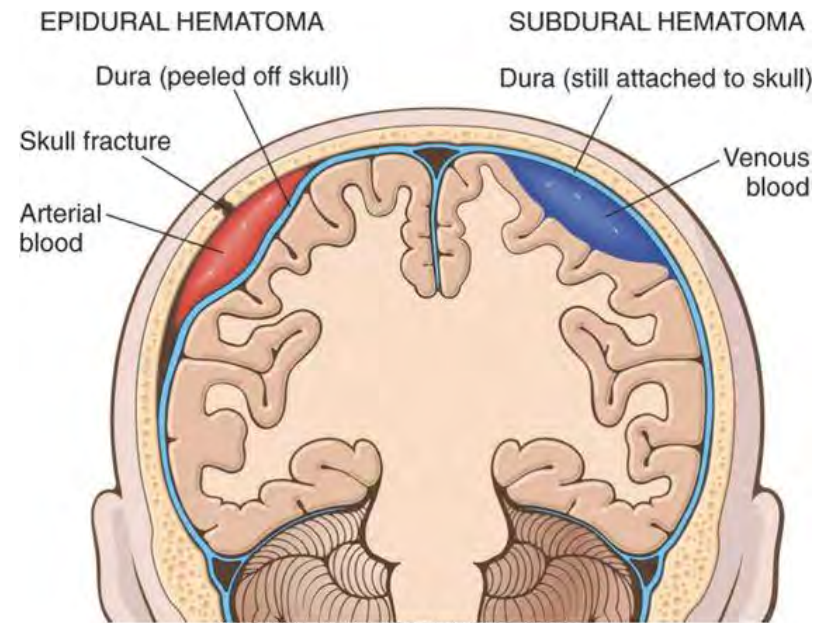
- Exam for concussion is frequently normal
  - *Structural versus functional*
- Mostly used to differentiate from or identify structural injuries to the head and spine
  - May coexist with concussion, share same mechanism
    - Medical emergencies, can result in death





# Epidural and Subdural Hematomas

- Likely to show changes in neurologic exam
  - Often progressive, over 24-72 hours
- If any of the following, seek emergent help
  - Loss of consciousness
  - Unequal pupils
  - Poor coordination
  - Personality changes



Kumar et al: Robbins & Cotran Pathologic Basis of Disease, 8th Edition.  
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# Spinal Injuries

- Concern for all concussions – especially if whiplash or hyperflexion to neck
- May go unrecognized in patient with altered mental status or distracting injury
- Use extreme caution in patients with:
  - Numbness or weakness, even if improving
  - Significant pain/tenderness to neck and/or back

# Use of Imaging

- Uncommon to require imaging in concussion
  - Useful only for finding structural changes
- CT Scans
  - Loss of consciousness at time of injury
  - Focal neurologic deficit at initial exam
- MRI
  - May be used in prolonged symptoms (>4 weeks)
  - Evaluating for structural predispositions – not “severe or prolonged concussion”
  - Newer sequencing showing promise
    - Testing for diagnosis vs. resolution vs. clearance

# Initial Management

- “Act like you’ve got the flu”
- Physical rest
  - Initially out of all exercise/sports involvement
    - Protection and energy conservation
  - *Discuss return to play with Kathy Thornton*
- Cognitive rest
  - May need time off school
  - *Discuss return to learn with Dr. Kulberg*



# Prognosis

- 85-90% return to baseline within 7-10 days
  - 98%+ better within 4 weeks
- Predictors of longer symptoms (> 4 weeks)
  - **NOT** LOC (amnesia 4-10x more predictive)
  - Previous concussion history
  - Personal or family history of headaches/migraines
  - Cognitive/“Foggy” feeling as worst symptoms
  - Multiple collisions before removed (vs single blow)
  - Females > males; High School > Professional



# Advanced Therapies

- Need versus want...
- Insomnia
- Headaches
- Cognitive deficits
- Dizziness, Imbalance
- Depression/Anxiety



# Insomnia

- Sleep hygiene!!
- Melatonin – safe first line (start early)
  - 2-5mg PO qhs
  - Very limited side effect profile
- Trazadone
  - Not something I use in pediatric population
- Avoid Ambien/benzodiazepines
  - Slow processing speed, already impaired



# Headaches

- Often poorly responsive to Ibuprofen/Tylenol
- Advanced medications considered if:
  - Symptoms past 4 weeks
  - Headaches predominant symptom
  - Interfering with academics, focus, concentration, sleep
- Temporary – need to remove before RTP
- \*\*Only treating headaches, not concussion
- \*\*All medications are off-label use in concussion



# Headaches

- Amitriptyline
  - Start very low, can raise as necessary
  - Adverse effects:
    - Fatigue – often desired, can have hangover effect
    - Prolonged QT – always obtain prior EKG
    - Mood changes



# Headaches

- Amitriptyline
- Topiramate
  - No heart effects, less interference with SSRIs
  - Less researched specifically in concussion



# Headaches

- Amitriptyline
- Topiramate
- Propranolol
  - Concern in athletes if return to play – affects appropriate HR/BP response to exercise



# Cognitive Deficits

- If chronic struggles academically (>4-6 weeks), especially if predominant symptom
- Amantadine
  - Teratogenic, consider UPT in postpubescent
  - Preferred in pediatrics
- Methylphenidate
  - Considered for adults/older adolescents



# Other Symptoms

- Balance/Dizziness
    - Vestibular therapy
  - Neck Pain
    - Craniosacral therapy, Cervical PT
  - Depression/Anxiety
    - Cognitive Behavioral Therapy (CBT)
    - Standard therapy/counseling
- \*Beware some limitations/rest effects

# Repeat Concussions

- After 1, patient 3x more likely to obtain 2<sup>nd</sup> within same season than peers without (Guskiewicz 2000)
  - 92% of in-season repeats are within 10d of return (Guskiewicz, JAMA 2003)
- Worrisome patterns
  - Longer, more severe symptoms
  - Less mechanism required
  - Persistent cognitive dysfunction



# Second Impact Syndrome

- Rare, possibly fatal complication of head injury
- Typically involves second injury while still recovering
  - Does NOT require significant blow or head trauma
  - Loss of regulation of blood flow – reversal of decreased cerebral perfusion
  - Severe diffuse edema, brain herniation, possible death
    - Survival often involves significant catastrophic neurologic injury
- Controversy over necessity of an initial injury
  - Versus separately described diffuse cerebral edema related to individual trauma

# Cumulative Effects

- Some permanent effect with each concussion
  - Cannot see it or quantify it
  - Must be present to allow cumulative effect
- After one, much more likely to get another (3x)
  - Part selection bias, part real cumulative effect
  - Longer, more severe symptoms
- No way of predicting individual response – even within the same patient





# Chronic Traumatic Encephalopathy (CTE)

- Distinct tauopathy of brain tissue
  - Unknown incidence in athletic populations
- Direct cause and effect relationship between CTE and concussions or exposure to contact sports has **not** yet been demonstrated
  - Few studies evaluating for this in general population
    - Noy *et al* (2016): 35% of normal population 18-60yo show at least minimal changes consistent with CTE
    - Alcohol use and head trauma seem to be significant factors
  - Caution in interpretation of causation in CTE case studies
  - Important to address the fears of parents/athletes

# Cumulative Effects

- Concerns for multiple other syndromes attributable to concussions
  - Depression
  - Dementia
  - Parkinsonism
  - Alzheimer's
  - Amyotrophic Lateral Sclerosis (ALS)
- **NONE** of these have been proven, with studies refuting increased risk



# Advice to Parents/Patient

- Reassurance, reassurance, reassurance
  - “You should get back to 100%”
  - No reason to believe that every patient won’t completely return to normal after first concussion
- Functional versus structural injury
  - Down at the cellular level – won’t see it on any imaging modality – no bruising, swelling, etc.
  - Essentially represents an energy deficiency
    - Justification for physical cognitive rest



# How Many is Too Many?

- No known answer – may never have one
  - 2 in same season, recommend done for season
- Varies based on age, level, future, etc.
  - Acceptance of risk...



CAUTION  
CAUTION

# Acceptance of Risk

CAUTION  
CAUTION

- Perhaps most important disclosure/advice
  - Most concussion guidelines are based on expert recommendations rather than high level evidence
- **Parents and patient have to know that all of these risks increase with any return to sport**



# Protective Gear

- At this point, we have no solid evidence that any piece of equipment has significant protection from concussion
  - Helmets
  - Bands
  - Mouthguards



# Resources

- **Literature**

- McCrory, P, Meeuwisse, W, et al. Consensus Statement on Concussion in Sport: the 3rd International Conference on Concussion in Sport held in Zurich, November 2012. *British Journal of Sports Medicine* 2013; 47: 250-258.
- McCrory, P, Meeuwisse, W, et al. Consensus Statement on Concussion in Sport: the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. *British Journal of Sports Medicine* 2009; 43 (Suppl 1): i76-i84.
- Halstead, ME, Walter, KD and THE COUNCIL ON SPORTS MEDICINE AND FITNESS. Clinical Report – Sport-Related Concussion in Children and Adolescents. *Pediatrics* 2010; 126 (3): published online Aug. 30, 2010.
- Meehan, WP and Bachur, R. Sport-Related Concussion. *Pediatrics* 2009; 123; (114-123)
- CDC “Heads Up to Clinicians” training program (preventingconcussions.org)

- **For Family and Parents**

- Meehan, William P, **Kids, Sports, and Concussion: A Guide for Coaches and Parents** [Praeger Publishing, Hardcover, 2011]
- CDC “Heads Up” program for coaches
  - <http://www.cdc.gov/concussion/HeadsUp/Training/HeadsUpConcussion.html>

