Evaluation and Management of Concussions in Kids and Teens

Brain Injury Alliance IOWA

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March 2, 2017

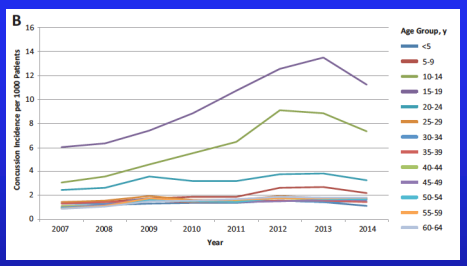
Rocky Mountain Center for Concussion
HealthONE

Objectives

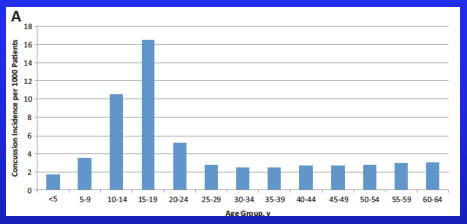
- Review signs and symptoms of concussion
- Review concussion risk factors
- Review basic concussion management
- Review current guidelines for clearance and return to play

What is a concussion?

- Definition
  - American Academy of Neurology
    - "a pathophysiologic disturbance in neurologic function characterized by clinical symptoms induced by biomechanical forces"
  - "A concussion is a brain injury that is caused by a sudden blow to the head or to the body. The blow shakes the brain inside the skull, which temporarily prevents the brain from working normally"
  - mTBI vs Concussion
    - GCS 13-15, LOC < 30 min, Posttraumatic amnesia < 24 hours
- 1.6 – 3.8 Million sports related mild head injuries each year in US
- 1.1-1.9 Pediatric (≤ 18 yo) concussions per year
  - Bryan MA, et al, Pediatrics 2016
- Estimated 42 million mTBI worldwide each year

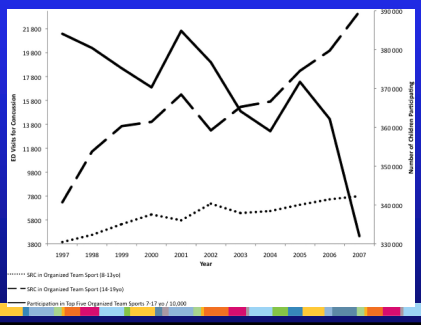


Zhang, et al Ortho J of Sports Med 2016

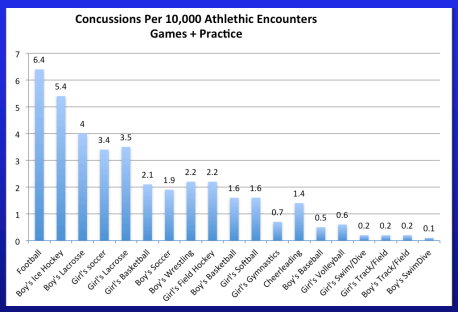


Zhang, et al Ortho J of Sports Med 2016

Bakhos LL, et al. Emergency Department Visits for Concussion in Young Child Athletes *Pediatrics* 2010:126(3)e550-e556
1997-2007: ED visits for concussion in orgainized team sports increased by >200% in 14-19 yrs, and doubled in 8-13 yrs



Epidemiology of Concussions Among United States High School Athletics in 20 Sports. Marar M, et al, 2012 American Journal of Sports Medicine



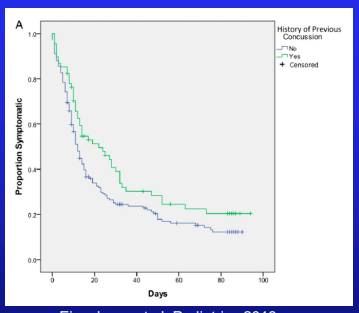
How to Diagnose a Concussion

- History of trauma → symptoms
- "Cognitive tests and post-concussion symptom scale is likely to distinguish children with and without mTBI"
  - Pediatric mTBI workgroup
  - Level B obligation: should use validated symptom scale

Risk Factors

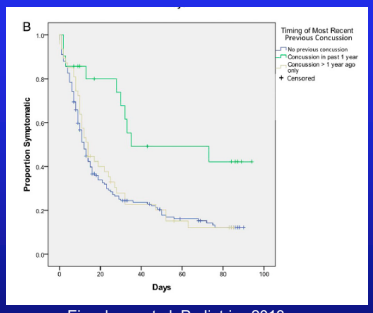
- Age
  - Weaker necks / torsos
  - May be more vulnerable to shear forces
  - Neurodevelopment: frontal/temporal lobes, pruning and mylelination into early 20's
  - Increased neuroplasticity: pro
- Gender
- Genetics
  - APOE ε-4 allele (affects amyloid-β clearance)
    - Clear increased risk Alzheimer's
    - Not clear influence on concussion outcome
- Underlying diagnosis
  - Learning disability
  - ADD/ADHD
  - Psych
  - Eye therapy / Strabismus
  - Migraine
  - Behavior problems
  - Poor pre-injury family functioning

Past Concussion



Eisenberg, et al, Pediatrics 2013

Past Concussion



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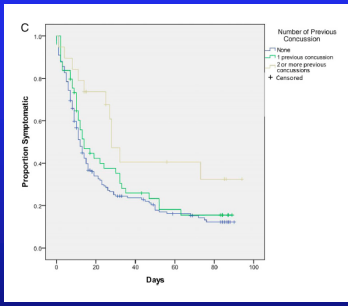
Past Concussion



Eisenberg, et al, Pediatrics 2013

Symptoms as risk factors

- Number of symptoms at time of injury
  - Eisenberg, et al. 2013
- Loss of Consciousness
  - ? marker of severity for long term outcome of concussion
- Dizziness
  - Lau B, Kontos A, Collins, M, et al AJSM, 2011
    - Predictive of protracted (>21days) recovery
  - Ellis MJ, 101 concussed kids < 19 years, 63% with VOD
    - 40 days to recover if VOD
    - 21 days to recover without VOD
- Fogginess
  - Iverson, Collins, et al, JINS, 2004
    - Predictive of neurocognitive deficits and prolonged recovery as measured by ImPACT
  - Lau B, Kontos A, Collins, M, et al AJSM, 2011
    - Fogginess at 3 days predictive of prolonged recovery

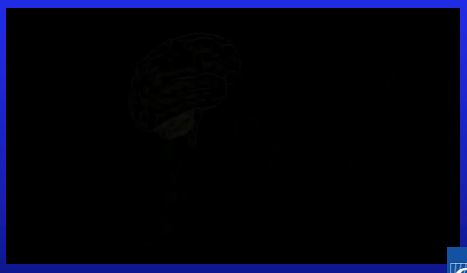
Symptoms as risk factors

- Amnesia
  - Erlanger, et al, 2003:
    - Self-reported memory problems at 24 hours post-injury predictive of severity
    - LOC not predictive of severity of concussion
  - Collins, et al, 2003
    - Presence of any amnesia predictive of post injury neurocognitive performance and symptoms.
- Migraine
  - Mihalik, et al, J Neurosurgery, 2005
    - Photosensitivity, photophobia and/or nausea
    - Post traumatic migraine group had increased impairment vs. non-migranous group
    - Pathophysiology of migraine and concussion similar

Delayed Reporting

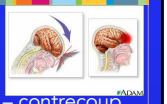
- Asken BM, et al, J Athl Train 2016
  - Retrospective chart review, college athletes
    - N = 75
  - Primary outcome measure: days from injury to clearance
  - 51% delayed reporting
  - 5 days longer to RTP in the delayed report group
- Elbin RJ, et al, Pediatrics August 2016
  - Prospective study, concussion specialty clinic
    - N = 62
  - Protracted recovery (≥ 21 days)
    - 80% played group vs. 31% removed group
  - Players who continued to play after injury took twice as long to revovery (44 days vs. 22 days)

Pathophysiology



Pathophysiology

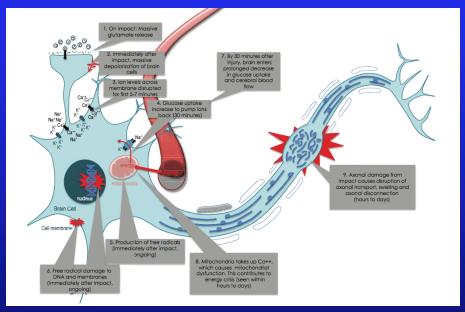
Pathophysiology



- Trauma to head or body causes coup – contrecoup injury with rapid acceleration – deceleration and rotational forces ➔damage to glial cells, neuronal cells and blood vessels
- Metabolic Cascade
- Period of vulnerability until resolution of metabolic crisis

Sports-Related Concussions in Youth:

Improving the Science, Changing the Culture (2014)



Evidence for metabolic vulnerability

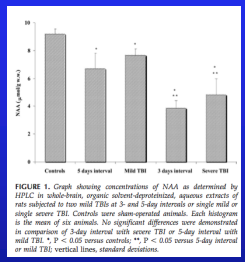


FIGURE 1. *Graph showing concentrations of NAA as determined by HPLC in whole-brain, organic solvent-deproteinized, aqueous extracts of rats subjected to two mild TBIs at 3- and 5-day intervals or single mild or single severe TBI. Controls were sham-operated animals. Each histogram is the mean of six animals. No significant differences were demonstrated in comparison of 3-day interval with severe TBI or 5-day interval with mild TBI. *, P < 0.05 versus controls; **, P < 0.05 versus 5-day interval or mild TBI; vertical lines, standard deviations.*

Vagnozzi, R. et al. Hypothesis of the postconcussive vulnerable brain: experimental evidence of its metabolic occurence. Neurosurgery. 2005 Jul;57(1):164-71

Metabolic Vulnerability

doi:10.1093/brain/awq200 Brain 2010: Page 1 of 11 | 1

BRAIN
A JOURNAL OF NEUROLOGY

Assessment of metabolic brain damage and recovery following mild traumatic brain injury: a multicentre, proton magnetic resonance spectroscopic study in concussed patients

Roberto Vagnozzi,[1] Stefano Signoretti,[2] Luciano Cristofori,[3] Franco Alessandrini,[4] Roberto Floris,[5] Eugenio Isgrò,[6] Antonio Ria,[3] Simone Marziale,[5] Giada Zoccatelli,[4] Barbara Tavazzi,[7] Franco Del Bolgia,[1] Roberto Sorge,[1] Steven P. Broglio,[8] Tracy K. McIntosh[9] and Giuseppe Lazzarino[10]

Figure 1 Axial MRI of a normal volunteer showing the single volume of interest (single voxel) located in the right frontal lobe, along axis

Bartnik-Olsen BL, et al. Impaired neurovascular unit function contributes to persistent symptoms. A pilot study.

J Neurotrauma 31: 1497-1529, Sept 1, 2014

- 15 patients (12 male, 3 female) ages 8-17 with sports concussion, 2.8-12 months post injury, all still with sx, in peds sports med clinic + matched controls
- MRI/MR Spec / DTI (PWI in 7 subjects)
  - Multivoxel technique NAA/Cr, NAA/Cho and Cho/Cr ratios
- In concussed patients
  - Lower cerebral blood flow and cerebral blood volume in certain regions
  - Reduced NAA/Cr and NAA/Cho in certain regions
- Findings "suggest that persistent neuronal metabolic dysfunction can occur long after mTBI"

Symptoms of Concussion

Physical		Cognitive
Headache/Pressure	Nausea	Feel in a "fog"
Blurred vision	Vomiting	Feel "slowed down"
Numbness/Tingling	Dizziness	Difficulty remembering
Sensitive to light	Poor balance	Difficulty concentrating/easily distracted
Ringing in ears	Noise sensitive	Slowed speech
Seeing "stars"	Disorientated	Easily confused
Glassy eyed	Neck Pain	

Emotional		Sleep/Energy	
Inappropriate emotions	Irritability	Fatigue	Drowsiness
Personality change	Sadness	Excess sleep	
Nervousness/Anxiety		Sleeping less than usual	
Lack of motivation		Trouble falling asleep	
Feeling more "emotional"			

Complications of Concussion

- Catastrophic Injury / Second Impact Syndrome
- Post-concussion Syndrome
- Decreased Cognitive Function
- Chronic Traumatic Encephalopathy

Catastrophic Injury

- Second Impact syndrome
  - First described 1973, Schneider
  - Only in high school and college age
  - Metabolic vulnerability after mTBI may result altered CBF regulation, rapid malignant cerebral edema and herniation with second, even minor impact (Cantu)
  - Rapid progression 2-5 min after hit
  - McCrory: review of SIS cases
    - Only 5/17 cases felt to be probable, ages 16-19 years.
    - Questions the existence of SIS
      - ? Diffuse cerebral edema from single impact
      - ? Genetic predisposition (ion channelopathy)

JAKE SNAKENBERG

Catastrophic Injury

- Acute Subdural most common cause of death due to head injury in sports
- Boden BP, et al. Catastrophic head injuries in high school and college football players, Am J Sports Med 2007 Jul;35(7)1075-81
  - Average of 7.23 catastrophic head injuries per year (94 injuries total 1989-2002)
  - 75 subdural, 10 Subdural with diffuse edema, 5 diffuse edema, 4 AVM
  - 59% prior head injury (71% of which were same season)
  - 39% playing with symptoms
- Cantu RC, Gean AD. Second-Impact Syndrome and a Small Subdural Hematoma: An Uncommon Catastrophic Result of Repetitive Head Injury with a Characteristic Imaging Appearance. J Neurotraum 2010 Sept (27)1557-64
  - Clinical deterioration too rapid to be caused by the subdural
  - Typical severe subdural presentation, severe trauma with immediate LOC due to RAS injury
  - Typical epidural presentation, more prolonged lucid interval
  - CT findings with SIS differ with engorged hemisphere, not mass effect from bleed

Annual survey of football injuries 1931-2014 National Center for Catastrophic Sport Injury

- 4,200,000 football participants at all levels of football
  - 100,000 high school
  - 3,000,000 youth
- 2014 season
  - 6 direct football fatalities (5 in high school, 1 collegiate)
  - 10 indirect fatalities (cardiac, heat stroke, hypernatremia)
  - 5 fatalities outside of exertional activity (cardiac)

FATALITIES DIRECTLY DUE TO FOOTBALL – 1931-2014[1]

	Sandlot	Pro & Semi-pro	High School	College	Total
TOTALS:	180	80	691	90	1041
Percent	17.3%	7.7%	66.4%	8.6%	100%

NCCSIR
National Center for Catastrophic Sport Injury Research

Post-Concussion Syndrome / Prolonged Recovery

- Definition of PCS unclear
- Eisenberg MA, et al. Time interval between concussions and symptoms duration. Pediatrics
  - 15% of ED patients ages 11-22 still symptomatic 90 days after injury
- Blume HK, Headache after pediatric TBI: A cohort study
  - ED and inpatients ages 5-17
  - 43% of mTBI patients had HA at 90 days compared to 23% of ortho controls
- Zuckerman, Predictors of PCS in collegiate athletes. Neurosurg Focus 2016
  - 7.8% with PCS at 4 weeks

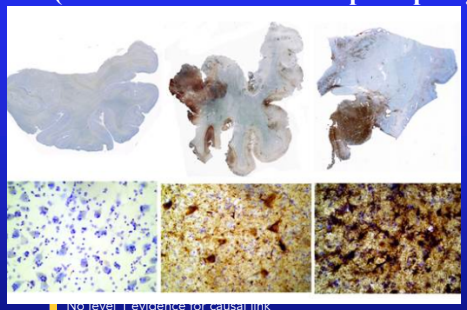
Cognitive Decline

- Long term neurocognitive effects of repetitive subconcussive impacts and multiple concussions poorly understood
- Other factors may affect cognitive function
  - Headache
  - Psychiatric dx
  - Ortho injury
- Data conflicting, many studies limited by small sample size, methodological weaknesses
- Limited imaging data suggest repetitive head impacts result in white mater integrity changes

Sub-concussive blows / cumulative injury

- Several studies have shown structural (white matter) and functional changes after single contact sport season
  - Clinical implications not clear

CTE (Chronic Traumatic Encephalopathy)



- No level 1 evidence for causal link

Boston University Brain Bank: Images from Website, Dr. Ann McKee

- 25 yo with widespread CTE
  - 16 yrs of football, 3 years D1 collegiate
  - 10 documented concussions
  - High School GPA 3.8, failed out of college jr year and retired from football due to postconcussive sx
  - Reported apathy, anhedonia, poor appetite, hypersomnia, feelings of worthlessness, possible suicidal ideation
  - Age 23: Marajuana use, abusive to wife
  - Age 24 enrolled in UNITE study, extensive neuropsych testing with some deficits
  - Age 25: died of staph aureus endocarditis (congenital bicuspid valve)

Evaluation / Management

- Prevention
- Pre-season
- Sideline
- ED / UC / Office
- Follow-up visits
- Clearance for RTP vs. chronic symptoms

Prevention

Prevention

- Helmets
  - Attenuate linear acceleration only
  - Decrease risk of skull fracture and bleeds
  - Do not decrease concussion rates
    - U of Wisconsin, no difference in concussion rates with star ratings of helmets and age of helmet
    - 2013 Institute of Medicine and National Research Council Report on youth sports-related concussions: "there is limited evidence that current helmet designs reduce the risk of sports-related concussions."
  - Good fit and well maintained important
- Helmet Accelerometers
  - No clear concussion threshold
  - Not yet useful for concussion diagnosis
  - May play a role in behavior modification (limit contact practices)
  - College: avg 1000 impacts per season
  - High school avg 774 impacts per season
- Helmet "add-ons"
  - AAN and NOCSAE statements
    - No evidence to support the use
  - Use of "add-ons" voids the NOCSAE certification

"Voila! … Concussion-proof!"

Prevention

- Head guards
  - Do not decrease concussion risk
  - ? Increase higher risk behavior

- Mouth guards
  - Help prevent dental injury
  - Do not decrease concussion risk
- Nutrition
  - Morley WA, Diminished brain resilience syndrome: A modern day neurological pathology of increased susceptibility to mild brain trauma, concussion, and downstream neurodegeneration, Surg Neurol Int. 2014 Jun 18;5:97. doi: 10.4103/2152-7806.134731. eCollection 2014
- Neck strengthening / conditioning

Prevention
Make sports safer / choose safer sports

- Rules / Coaching
  - USA Football: Heads Up Tackling in football
    - Kerr ZY, Ortho J Sports Med, youth leagues with HUT + limited contact practices lower rates of injury (same rate with and without HUF)
  - Proper blocking technique in football
  - Enforcement of rules
    - NFL, NHL, NCAA: no contact on defenseless players and hits from behind
  - Update rules as new information becomes available
  - Limit full contact practices
    - Broglio SP, J Athle Train 2016, decreased number of hits by 18-48%
- Increase access to rec-level sports
- Athletic trainers

Prevention
Make sports safer / choose safer sports

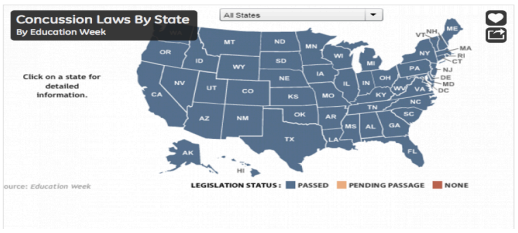
- Stamm JM, et al. Age of first exposure to football and later-life cognitive impairment in former NFL players
  - Critical stage of brain development ages 10-12
  - Retired NFL football players who started tackle football < age 12 poorer cognitive outcomes than those who started at or later than age 12
- Cantu: "no tackle football before the age of 14"
  - "No brain trauma is good trauma"
  - Kids have weaker necks
  - Period of critical brain development
  - Limit tackling practice

The importance of concussion education and culture change

Labron James Video

Culture change

Last updated: 2/19/2014



Source: National Conference of State Legislatures, 2013.[6]

Most concussion in sports laws include three action steps:

1. **Educate Coaches, Parents, and Athletes:** Inform and educate coaches, athletes, and their parents and guardians about concussion through training and/or a concussion information sheet.
2. **Remove Athlete from Play:** An athlete who is believed to have a concussion is to be removed from play right away.
3. **Obtain Permission to Return to Play:** An athlete can only return to play or practice after at least 24 hours *and* with permission from a health care professional.

Iowa Code Section 280.13C
An Act concerning the protection of student athletes from concussions and other head injuries.

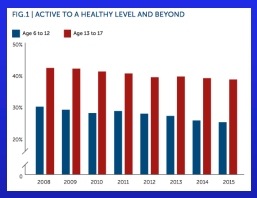
- *Education of coaches, students and parents by high school athletic associations*
- *Annual concussion / brain injury info sheet given by school to parents/guardians and students signed by parent/guardian*
- *Immediate removal from activity for suspected concussion or brain injury*
- *Written medical clearance to start GRP (Physician, PA, Chiropractor, NP, nurse, PT, licensed AT)*

- Has legislation helped us?
  - No enforcement
  - Increased awareness: one study showed an increase in ED visits for pediatric patients after law in effect
  - 2 other studies showed no change in rate of players who report playing with concussive symptoms
  - No studies to look at change in outcome

Balanced Discussion

- CDC
  - 12.5 million (about 17%) kids and teens are obese
- US Surgeon General
  - Urges "exercise as a means to reduce the risk of chronic diseases such as obesity and diabetes"
- Outside play has decreased
- PE eliminated or limited at many schools
- Sports are not accessible to many youth

THE ASPEN INSTITUTE
PROJECT PLAY
REIMAGINING YOUTH SPORTS IN AMERICA



- The State of Play 2016

http://www.aspenprojectplay.org/sites/default/files/StateofPlay_2016_FINAL.pdf

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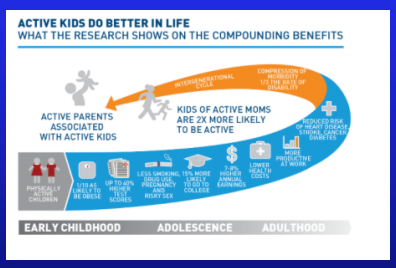
Balanced Discussion

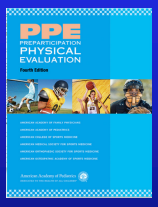


Evaluation / Management

- Prevention
- Pre-season
- Sideline
- ED / UC / Office
- Follow-up visits
- Clearance for RTP vs. chronic symptoms

Preseason Evaluation

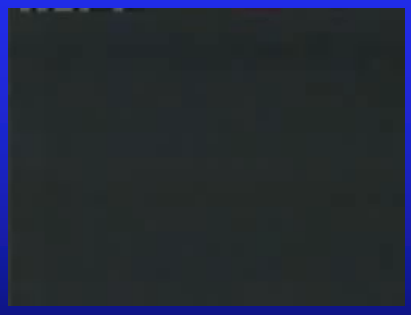
- History
  - Prior head injuries or concussion symptoms
- Physical Examination
  - Consider baseline assessments
    - King Devick
    - BESS (Balance Error Scoring System)
    - Baseline neuropsychological test
      - 4th Zurich: helpful in RTP decision
- Concussion education



Sideline Evaluation

- Role of ATC critical
- Look for signs of concussion
  - Dazed, glassy eyed, slowed response or speech, forgets plays, balance and coordination problems,

- Look for signs of concussion
  - Dazed, glassy eyed, slowed response or speech, forgets plays
- Symptoms assessment
- Evaluation of cognitive function essential
  - Standard orientation questions (person, place and time) inadequate, need specific memory testing



Sideline Evaluation

- Remove any player with signs/symptoms of concussion
- Frequent reassessment is critical
- Disregard athletes wishes to return-to-play
- If there is no emergency
  - Must be continuously observed until evaluated by health care professional
  - Specific evaluation every 5-10 minutes
  - NFHS: "Never send a player with a suspected concussion to the bus or locker room alone"

Transport

(Possible Immediately Life Threatening Injury)

- Deterioration of neurologic function
- Decreasing level of consciousness
- Decrease or irregularity of respirations or pulse
- Unequal, dilated, or unreactive pupils
- Any signs or symptoms of associated injuries, spine or skull fracture or bleeding
- Mental status changes: lethargy, difficulty maintaining arousal, confusion or agitation
- Seizure activity

Guskiewicz KM, et al. National Athletic Trainers' Association Position Statement: Management of Sport-Related Concussion. J Athl Train 2004;39(3):280-297

Referral for urgent medical evaluation (Potential for Deterioration)

- Loss of consciousness on the field
- Amnesia longer than 15 minutes
- Increase in blood pressure
- Vomiting
- Motor, sensory, balance or cranial nerve deficits subsequent to initial on-field assessments
- Post-concussion symptoms that worsen
- Additional post-concussion symptoms compared with those on the field
- Athlete is still symptomatic at the end of the game

Guskiewicz KM, et al. National Athletic Trainers' Association Position Statement: Management of Sport-Related Concussion. J Athl Train 2004;39(3)280-297

Non-urgent medical evaluation

(Concussion)

- Any of the findings in the day-of-injury referral category
- Postconcussion symptoms worsen or do not improve over time
- Increase in the number of postconcussion symptoms reported
- Postconcussion symptoms begin to interfere with the athlete's daily activities (i.e., sleep disturbances or cognitive difficulties

Guskiewicz KM, et al. National Athletic Trainers' Association Position Statement: Management of Sport-Related Concussion. J Athl Train 2004;39(3)280-297

Initial Medical Evaluation History

- Mechanism of Injury
- Risk factors
- Prior TBI / Concussion
- Graded Symptom Checklist
  - SCAT or REAP
- Vestibular and Oculomotor Complaints
  - Dizziness, motion sickness, nausea
  - Double vision, blurry vision, trouble changing focus

Initial Medical Evaluation Physical Exam

- Vital signs (orthostatic)
- GEN: Appearance, mood, affect
- HEENT: Signs of trauma to head, pupils, EOM, nystagmus, vestibular and oculomotor tests, fundoscopic exam, hemotympanum
- NECK: Range of motion, tenderness
- CAR: Arrhythmia, postural tachycardia
- CHEST/ABD/MS: associated injuries
- NEURO: Detailed neuro exam
  - Mental Status, Cognitive Function, Gait, Balance (BESS)
- Cognitive Function
  - SCAT 3, Child SCAT3 (age 12)—Sport Concussion Assessment Tool
  - Computer-based Neurocognitive Test

- Mutuszak JM, et al. A practical concussion physical examination tool box. Evidence-based physical examination for concussion Sports Health 2016 May/Jun;8(3):260-269

Imaging

- Plain film
  - Skull
  - Cervical Spine
- MRI
- Head CT

Indications for C-spine x-ray

- High-risk mechanisms of injury
- Multi-system trauma with severe injuries
- Other pain or injuries that distract the patient
- Injury above the clavicles
- Altered mental status and/or unable to verbalize or cooperate with the examination
- Neck pain, tenderness, deformity, or limitation of movement
- Acute neurologic deficit, especially paresthesias

MRI (Magnetic Resonance Imaging)

- Magnet / Radio Waves
- Benefits
  - Better images of brain/soft tissue that CT
  - No radiation
- Typically not indicated in acute trauma / ED setting except in spinal cord injury
  - Patient selection (no implanted devices, metal)
  - Slow, Loud, Confined space
- No data to identify indications for M

CAT (Computed Axial Tomography)

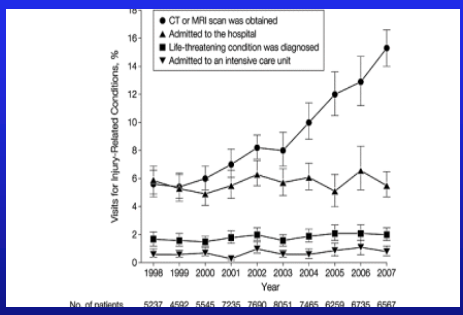
- Benefits
  - Scanner more open than MRI
  - Faster and quieter than MRI
  - More readily available
  - Better identification of bony injury (fracture) and acute traumatic injury
- Downside
  - Radiation: Cancers

Goal of Imaging in TBI

- Identification of potentially life threatening hematomas / fractures / swelling of the brain
  - Fewer than 10% of mild CHI patients have a finding on CT
  - Even fewer require medical or neurosurgical intervention
  - In a concussion CT is normal by definition

CT use in the United States

- Invented in 1974
- Installation began in 1976
- Initially very slow, required sedation of peds patient
- Helical CT allows much faster imaging, better resolution
- Pediatric CT now 16% of all CT in US



Radiation Exposure

- Radiation dose of a CT scan is 50 – 250 times that of a conventional x-ray
- CT scanning is the largest contributor of medical radiation doses in the US (15% of peds studies are CT, account for 70% of medical rads)
- Risk is cumulative
- Getting a head + abd/pelvis or chest increases risk by several magnitudes

Cancer Risk From CT

- Models developed from projections using Hiroshima atomic bomb survivors
- Risk of cancer from single abdominal CT in a child is 1/1000
  - Single head CT 1/1400
  - Risk cumulative
- Leukemia: decade after exposure
- Solid Tumors: 20-50 years after exposure
- 1.5-2% of cancers in US due to medical radiation = 1.4 million cancers per year (assumes pediatric dosing)
- 14,500 – 29,000 Cancer deaths per year attributable to medical radiation

Strategies for Reducing Radiation Exposure

- Lower doses in pediatric patients (Image Gently) – "ALARA"
  - Image Wisely (adults)
- Scan only the area required
- Image the appropriate patients
  - Validated pediatric decision rule
- Alternate strategies for managing patients (observation)

Avoiding CT in Pediatric Patients

- PECARN Decision Rule
  - Identification of low risk patients
    - Patients < 2: ¼ of CT's can be avoided
    - Patients >2: 1/5 of CT's can be avoided

Kupperman N, et al. Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort. Lancet 2009

PECARN Decision Rule

- High Risk
  - GCS 14 or lower
  - Other signs of altered mental status
  - Palpable skull fracture < 2 years of age
  - Signs of basilar skull fracture 2-18 years of age

PECARN Decision Rule

- Intermediate Risk
  - < 2 years of age
    - Scalp hematoma (occipital, parietal or temporal)
    - LOC >= 5 seconds
    - Severe mechanism
    - Not acting normally per parent
  - 2-18 years of age
    - LOC
    - Vomiting
    - Severe Mechanism
    - Severe Headache

PECARN Decision Rule

- Low risk
  - None of the findings in intermediate or high risk patients
    - Normal metal status
    - No evidence of skull fracture or non-frontal scalp hematoma (< 2years of age)
    - No vomiting
    - No severe headache
    - No h/o LOC
    - Minor mechanism

Bottom Line

- Don't promise a parent a CT
- Observation within the Emergency Department is appropriate for some patients in order to avoid CT
- If you really need a CT it is worth the risk

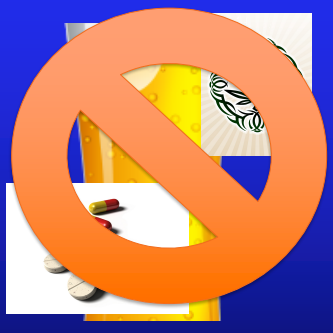
Concussion Management

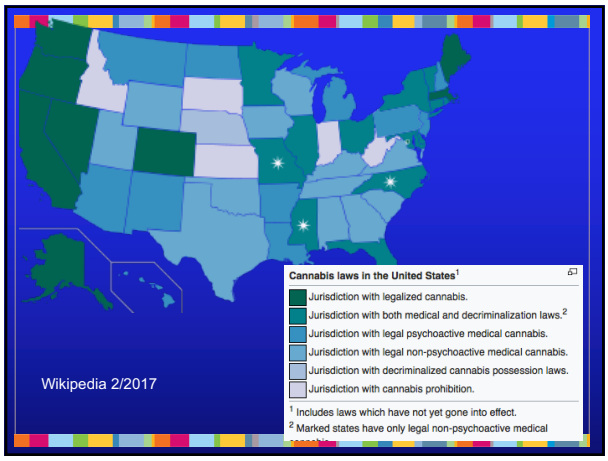
- Reassurance and Education
  - 70-80% resolve within 1-3 months
  - Advised on risk factors for prolonged recovery
- Rest
  - Physical rest
    - No cocooning
    - Sleep hygiene
    - Gradual return to daily activity
  - Moderate cognitive rest
    - Restrict media and texting
    - Avoid loud and busy places
    - Paced return to school
    - Avoid driving

"Yo, Dewey! Got another one over here when you're done."

Concussion Management

- Nutrition
  - Fish Oil supplements
    - Anti-excitotoxic, antioxidant and anti-inflammatory effects in brain tissue
    - 50 mg/kg/day total Omega-3, max 3-4 grams
    - Heavy Metal/mercury free
- Hydration





The REAP Project

- ED-REAP
- REAP Concussion Booklet
  - Endorsed as a recommended Concussion Management Protocol by the:
    - Colorado TBI Trust Fund
    - Brain Injury Association of Colorado
    - Colorado High School Activities Association
    - Reviewed and supported by the National Federation of High School Coaches
    - Reviewed and supported by the Pediatric BrainLINE website.

ED-REAP

13 HealthONE ED's

Diagnosis of concussion in ED

Parents given REAP booklet in ED

Fax a release to RM Center for Concussion

Call to the school to provide notification and education

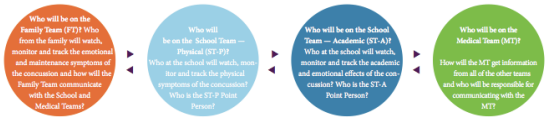
A Multi-Disciplinary Team is essential

Shared responsibility of the management of the concussion is essential. Multiple perspectives

and

Multiple sources of data

REAP is a Community-Based Concussion Management Protocol:



Every student-athlete is a student first and an athlete second

Mark E. Halstead, Karen McAvoy, Cynthia D. Devore, Rebecca Carl, Michael Lee, Kelsey Logan, Council on Sports Medicine and Fitness, and Council on School Health. Returning to Learning following a concussion. Pediatrics 2013; 132:5 948-957;

STEP THREE: ADJUST/ACCOMMODATE for PARENTS.

AFTER YOUR CHILD HAS RECEIVED THE DIAGNOSIS OF CONCUSSION by a healthcare professional, their symptoms will determine when they should return to school. As the parent, you will likely be the one to decide when your child goes back to school because you are the one who sees your child every morning before school. Use the chart below to help decide when it is right to send your child back to school:

STAY HOME- BED REST

If your child's symptoms are so severe that he/she cannot concentrate for even 10 minutes, he/she should be kept home on total bed rest - no texting, no driving, no reading, no video games, no homework, limited TV. It is unusual for this state to last beyond a few days. Consult a physician if this state lasts more than 2 days.

MAXIMUM REST = MAXIMUM RECOVERY

STAY HOME – LIGHT ACTIVITY

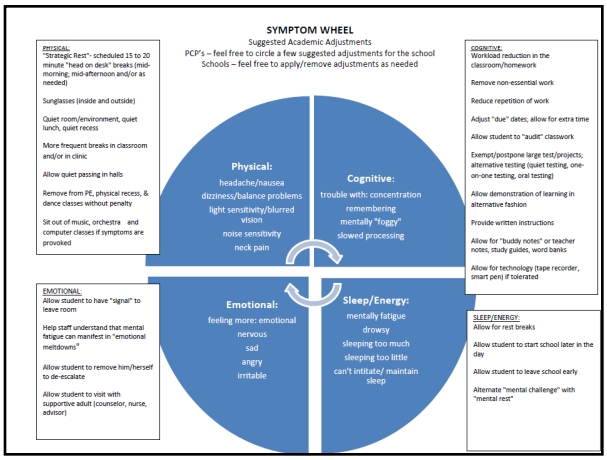
If your child's symptoms are improving but he/she can still only concentrate for up to 20 minutes, he/she should be kept home — but may not need total bed rest. Your child can start light mental activity (e.g. sitting up, watching TV, light reading), as long as symptoms do not worsen. If they do, cut back the activity and build in more REST.

NO physical activity allowed!

TRANSITION BACK TO SCHOOL

When your child is beginning to tolerate 30 to 45 minutes of light mental activity, you can consider returning them to school. As they return to school:

- Parents should communicate with the school (school nurse, teacher, school mental health and/or counselor) when bringing the student into school for the first time after the concussion.
- Parents and the school should decide together the level of academic adjustment needed at school depending upon:
  - ✔ The severity of symptoms present
  - ✔ The type of symptoms present
  - ✔ The times of day when the student feels better or worse
- When returning to school, the child MUST sit out of physical activity – gym/PE classes, highly physically active classes (dance, weight training, athletic training) and physically active recess until medically cleared.
- Consider removing child from band or music if symptoms are provoked by sound.



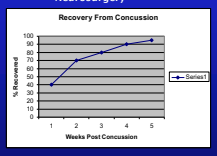
How bad is my concussion?

- Symptoms may get worse over the first 72 hours
  - "Monday morning concussion"
- We only know how bad a concussion was once it has resolved.
- Grading scales are no longer recommended
- Clearance for "Return-to-Play" should not take place in the ED or while still symptomatic

Return to Play

- Individualize, can't predict recovery
- Off all medications
- Symptoms attributable to concussion resolved
- Normal physical exam
- Neurocognitive recovery
  - Neurocognitive testing
  - Teacher feedback

Collins et al, 2006 Neurosurgery



» Teacher Feedback Form

Date _____

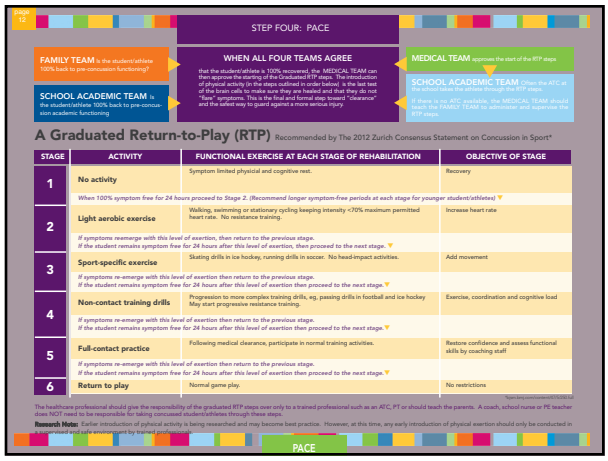
Student's Name _____

Date of Concussion _____

Student: you have been diagnosed with a concussion. It is your responsibility to get-or data from your teachers before you return to the doctor for a follow-up visit. A day or two before your next appointment, go around to all of your teachers (especially the CORE classes) and ask them to fill in the boxes below based upon how you are currently functioning in their class(es).

Teachers: Thank you for your help with this student. Your feedback is very valuable. We do not want to release this student back to physical activity if you are still seeing physical, cognitive, and emotional or sleep/energy symptoms in your classroom(s). If you have any concerns, please state them below.

1. Your name 2. Class taught	Is the student still receiving any academic adjustments in your class? If so, what?	Have you noticed, or has the student reported, any concussion symptoms (e.g., headaches, dizziness, fatigue, difficulty concentrating, nervousness, more irritable, fatigue more than usual, etc.)? If yes, please explain.	Do you believe this student is performing at their preconcussion learning level?
			❑ Yes ❑ No Date: Signature:
			❑ Yes ❑ No Date: Signature:
			❑ Yes ❑ No Date: Signature:
			❑ Yes ❑ No Date: Signature:



When to call it quits: Retirement from Sport

- A DECISION TAKEN VERY SERIOUSLY
  - Balanced discussion
- It is not always the number of concussions an athlete has, it is the "burden" of each concussion
  - Severity of symptoms
  - Length of recovery
  - Residual symptoms
- Retirement should be discussed if:
  - Increasing burden
  - Pattern suggesting less "force needed" to create a concussion
  - Injuries closely spaced

Absolute contraindications for return to contact sport postconcussion

Table.
Absolute contraindications for return to contact sport postconcussion.

Persistent PCS (8,41)
Permanent neurological injury (8)
Permanent deficit on neuropsychological testing (29)
Second impact syndrome (8)
Subarachnoid hemorrhage (8,38)
Hydrocephalus (8)
Imaging results that increase the risk for future brain injury[a] (5)
Symptomatic Type I Chiari malformation (38,41)

[a] Edema, hemorrhage, hydrocephalus, and arachnoid cyst.

Concanon L, et al The million dollar question: when should an athlete retire after a concussion. Competitive Sports. 2014

Unknowns / Future Research

- Consensus definition of concussion
- True incidence of concussion
  - Improved surveillance and data sharing
- How to predict prolonged recovery in an individual
- Objective measures for diagnosis and determination of complete recovery
  - Serum biomarkers
  - Imaging (DTI, fMRI, PET, TMS, FA, MRS, volumetric imaging)
  - Oculomotor function (eye tracking)
- What are the long-term risks of contacts sports, concussion and subconcussive blows
- Epidemiology and cause of CTE, AD, PD, CNI

Oculogica Study

Research

- UNITE study (Understanding Neurologic Injury and Traumatic Encephalopathy)
- NCAA-DOD Grand Alliance Concussion Assessment Research and Education (CARE) Consortium
- Big 10/Committee on Institutional Cooperation-Ivy League Traumatic Brain Injury Research Collaboration
- Take C.A.Re (Concussion Assessment and Recovery Research): peds, Melbourne Australia
- Need large longitudinal studies in youth athletes

Resources

- CDC Heads up programhttp://www.cdc.gov/headsup/
- CDC Concussion at Play Playbookhttp://www.cdc.gov/headsup/pdfs/resources/concussion_at_play_playbook-a.pdf
- National Operating Committee on Standards for Athletic Equipment http://nocsae.org
- Brain Injury Alliance of Iowa http://biaia.org
- Iowa Concussion Consortium: REAP booklet http://biaia.org/ICC/index.htm

- NFHS: National Federation of High Schools
  - www.nfhslearn.com
- Concussion Legacy Foundation (Sports Legacy Institute) http://concussionfoundation.org
- Rocky Mountain Center for Concussion www.center4concussion.com
- Aspen Institute, Project Play https://www.aspenprojectplay.org

Summary

- Recognition of symptoms and removal from play is critical
- Parents and youth athletes need to be aware of risks of sports and risks of concussions
- REAP is a helpful concussion management tool for the first 3 weeks after injury
- Medical providers need to be aware of current concussion guidelines, legislation and return to play criteria

Questions?

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