



What Is Concussion: The Science of Neurotrauma

Presented by:

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Team Physician USA Rugby
Team Physician USA Wrestling
Team Physician USA Track and Field



WHO AM I



- Naval Medical Center Portsmouth
- Joint Expeditionary Base Little Creek-Fort Story, Virginia Beach VA
 - General Medical Officer Naval Special Warfare Group 2 Logistic and Support Unit
- Naval Medical Center Portsmouth/Naval Station Norfolk, Portsmouth/Norfolk VA
 - General Medical Officer Occupational Health Naval Medical Center Portsmouth and Joint Enabling Capability Command
- Naval Undersea Medical Institute & Naval Diving Salvage and Training Command
 - Undersea/Diving Medical Officer Candidate
- Naval Base Kitsap, Silverdale WA
 - Undersea Medical Officer, Lead PRP CMA
- St Petersburg General Hospital Family Medicine Residency
- Auburn University
 - 22 Sports
 - 570+ athletes
- Auburn University at Montgomery
 - 10 Sports
 - 170+ athletes
- Tuskegee University
 - 10 Sports
 - 170+ athletes
- Central-Phenix City High School
- 7A Alabama High School





OVERVIEW

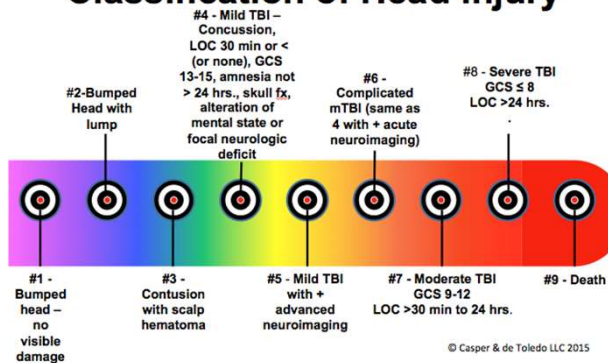
- What is neurotrauma?
- What are the symptoms of a concussion?
- How are concussions recognized?
- How is a concussion treated?



NEUROTRAUMA

- The mTBI to TBI continuum

Classification of Head Injury





COMMON CAUSES

- Motor Vehicle Collisions
- Military Combat
 - Blast injuries
 - 20% of soldiers in Iraq and Afghanistan
- Falls
 - Toddlers
 - Elderly
- Sports
 - Most common between 15-25 years of age



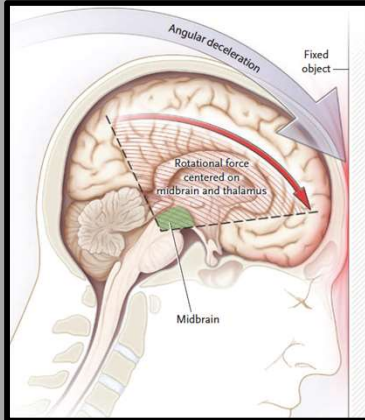
WHAT IS A CONCUSSION?

- Definition: "Complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces"
 - Physical force disrupting brain function
- Any change in neurologic/mental function
 - About 10% involved loss of consciousness
- Referred to as mild traumatic brain injury (mTBI)
- Majority of the time without CT/MRI changes





WHAT IS A CONCUSSION?



- Trauma that causes the brain to shake inside the skull
- Wave of motion causes damage to brain tissue
- Nerves and vessels can shear
- Brain cells are affected through direct damage, chemical changes and



MECHANISM OF INJURY

- Bottom line up front
 - DESPITE ADVANCES - THE UNDERLYING MECHANISMS ARE YET OT BE FULLY ELUCIDATED
- Brain insult
- Mechanical injury
- Physiological response
- Resolution vs persistence



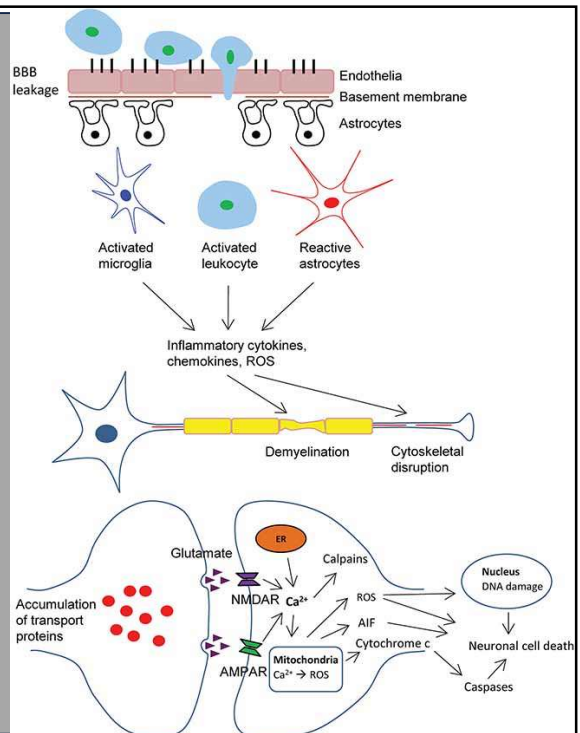
MECHANISM OF INJURY

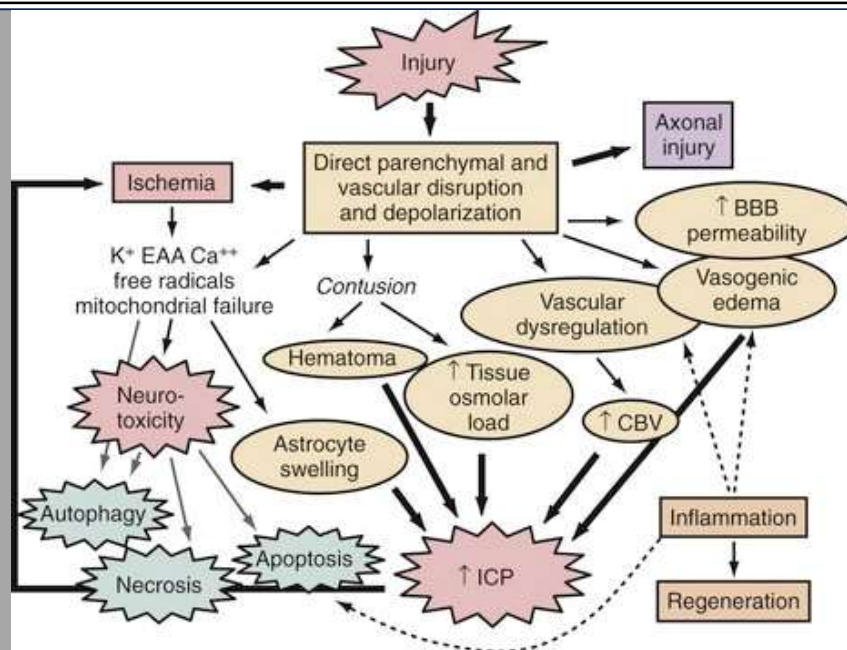
- Animal studies show rupture of bridging subdural veins and brain contusions with straight or translational forces
- ...diffuse brain injury from shearing forces with rotation or angular acceleration/deceleration forces
- Remember the brain stem is literally suspended in cerebral spinal fluid
 - Coup - brain affected directly at site of impact
 - Countercoup - opposite side
- Categories
 - Closed head
 - Penetrating
 - Explosive blast



PATHOPHYSIOLOGY

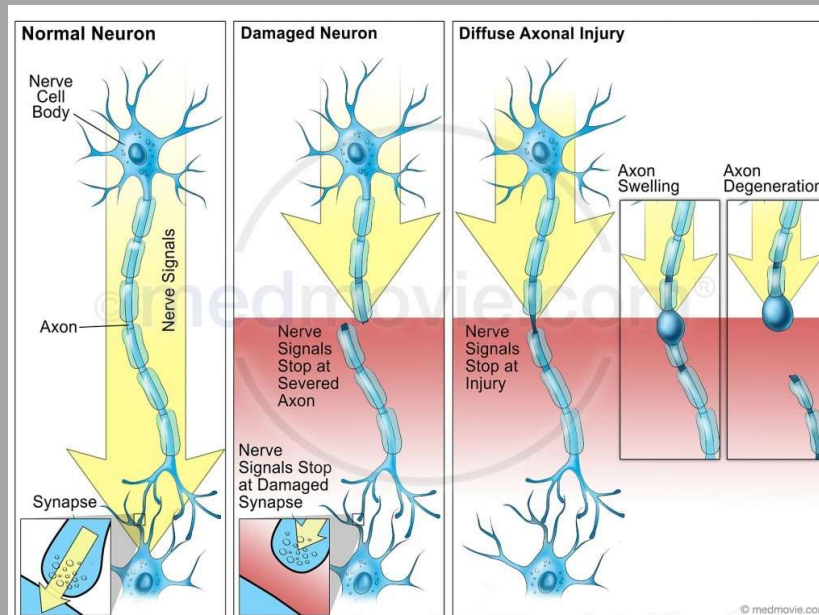
- Primary
 - From mechanical forces
- Secondary
 - Further tissue and cellular damages





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AXONAL INJURY





SECONDARY CHANGES

- Cerebral hypoxia
- Local acidosis
- Lactic acid accumulation
- Disruption of neural-active peptides
- Petechial hemorrhages
- Cell loss
- Mitochondrial dysfunction

Anatomy of a Concussion



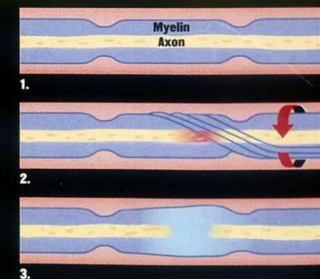
A blow to the head, such as a quarterback might receive from a defender's helmet, causes the brain not only to move forward and/or back in the skull but also to rotate, which distorts the axons that connect the brain cells, or neurons.



1. In a normal neuron, the axon, which is protected by a myelin sheath, is not broken or otherwise distorted.

2. After a concussive blow, an axon might twist or bend, interrupting communication between neurons.

3. If a concussion is severe enough, the axon swells and disintegrates. Less severely damaged axons return to normal.



CONCUSSION STATISTICS

- 1.5-3.8 million people experience these injuries yearly
 - 9% of high school athletes
- 85% of people experience no long term symptoms
- >62000 concussions per year in high school contact sports (63% from football)
 - 15-20% of high school football players annually
- Likely under reported





RISK FACTORS

- Increased risk
 - Past concussion
 - Female athletes
 - Contact sports
- Prolonged recovery
 - Number, severity and duration of symptoms
 - H/O migraines, depression, mood disorders, developmental disorders



SYMPTOMS

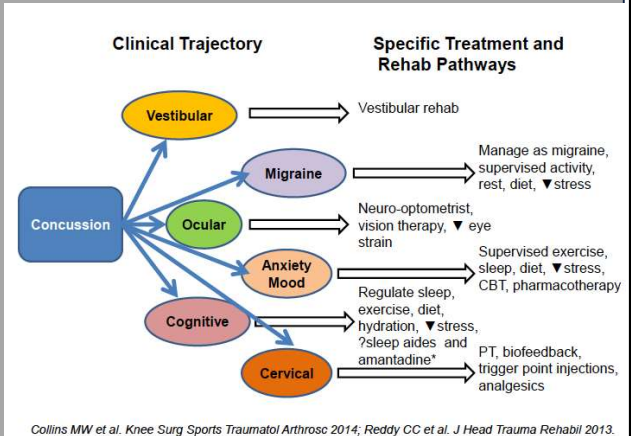
Various symptoms may occur, may not occur immediately

- | | |
|---|--|
| <ul style="list-style-type: none">• Headaches<ul style="list-style-type: none">• Most common symptom• Nausea• Confusion• Slow thinking | <ul style="list-style-type: none">• Sleep changes• Mood changes• Dizziness• Balance problems• Feeling irritable/emotional• Visual changes |
|---|--|

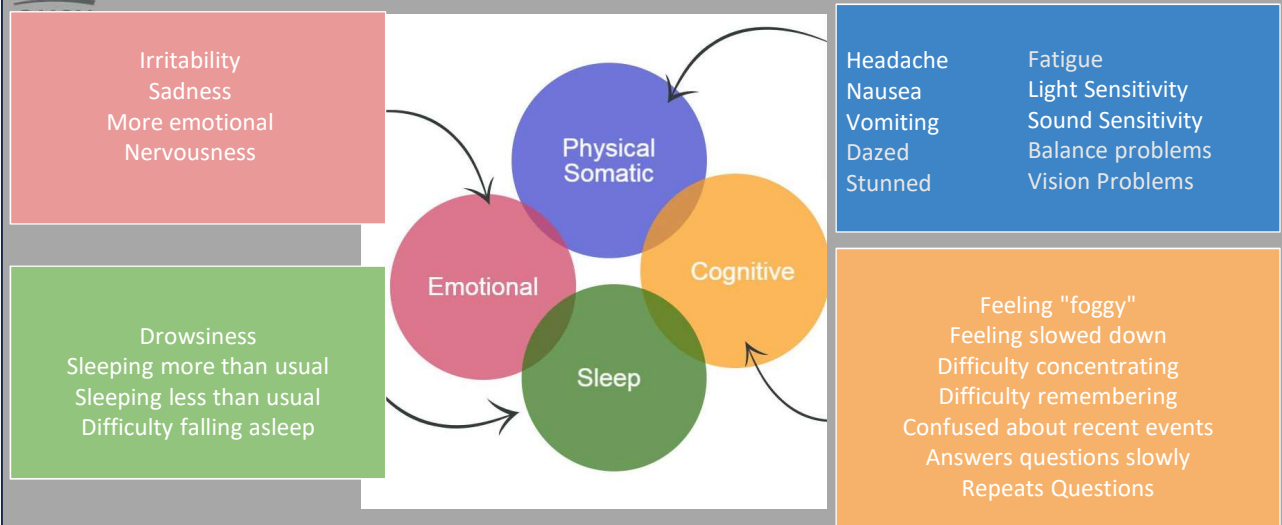


SYMPTOM PROGRESSION

- Concussions are not linear correlated injuries
 - Premorbid conditions
 - Mechanistic load
 - Vulnerability - Development



SIGNS AND SYMPTOMS OF CONCUSSION

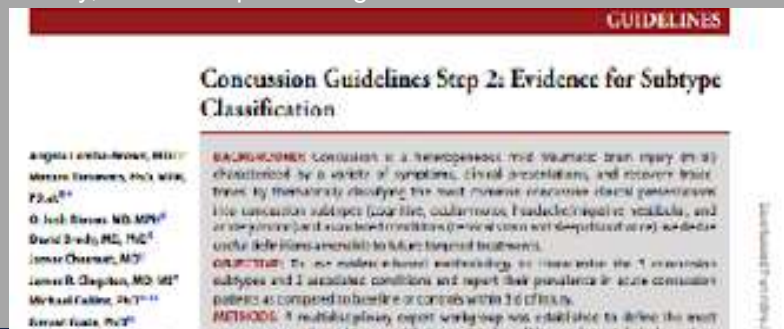




CLINICAL SCIENCE - PATHWAYS

- Predominant concussion subtypes
 - Cognitive
 - Ocular-motor
 - Headache/migraine
 - Vestibular
 - Vestibulo-ocular, visual motion sensitivity, vestibule-spinal and gait disturbance
 - Anxiety/mood
- Concussion-associated conditions
 - Sleep disturbance
 - Cervical strain

- Is healing linear, step wise, undulating
- Can we switch subtypes?



DIAGNOSIS

- Clinical diagnosis
 - Trained healthcare provider
- Graded system checklist
 - Objective tool
 - Tracking over serial exams
- Standardized assessment tools
 - Provides structure for evaluation
 - Limited validity





SIDELINE ASSESSMENT/MANAGEMENT

- Remove from play
- Assessment
 - Symptoms checklist
 - SCAT
 - Cognitive evaluation
 - Balance tests
 - Neurological physical examination

BESS Balance testing errors

- Hands lifted off iliac crest
- Opening eyes
- Step, Stumble, or fall
- Moving hip into >30 degrees abduction
- Lifting forefoot or heel
- Remaining out of test position >5s

SCAT5

SPORT CONCUSSION ASSESSMENT TOOL – 5TH EDITION
DEVELOPED BY THE CONCUSSION IN SPORT GROUP
FOR USE BY MEDICAL PROFESSIONALS ONLY

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FEI

Cognitive assessment

Standardized Assessment of Concussion (SAC)*

Orientation (1 point for each correct answer)

What month is it?	0	1
What is the date today?	0	1
What is the day of the week?	0	1
What year is it?	0	1
What time is it right now? (within 1 hour)	0	1
Orientation score	of 5	

Immediate memory

List	Trial 1	Trial 2	Trial 3	Alternative word list			
elbow	0	1	0	1	candle	baby	finger
apple	0	1	0	1	paper	monkey	penny
carpet	0	1	0	1	sugar	perfume	blanket
saddle	0	1	0	1	sandwich	sunset	lemon
bubble	0	1	0	1	wagon	iron	insect
Total							

Immediate memory score total

Concentration: Digits Backward

List	Trial 1	Alternative digit list			
4-9-3	0	1	6-2-9	5-2-6	4-1-5
3-8-1-4	0	1	3-2-7-9	1-7-9-5	4-9-6-8
6-2-9-7-1	0	1	1-5-2-8-6	3-8-5-2-7	6-1-8-4-3
7-1-8-4-6-2	0	1	5-3-9-1-4-8	8-3-1-9-6-4	7-2-4-8-5-6
Total of 4					

Concentration: Month in Reverse Order (1 pt. for entire sequence correct)

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan	0	1
Concentration score	of 5	



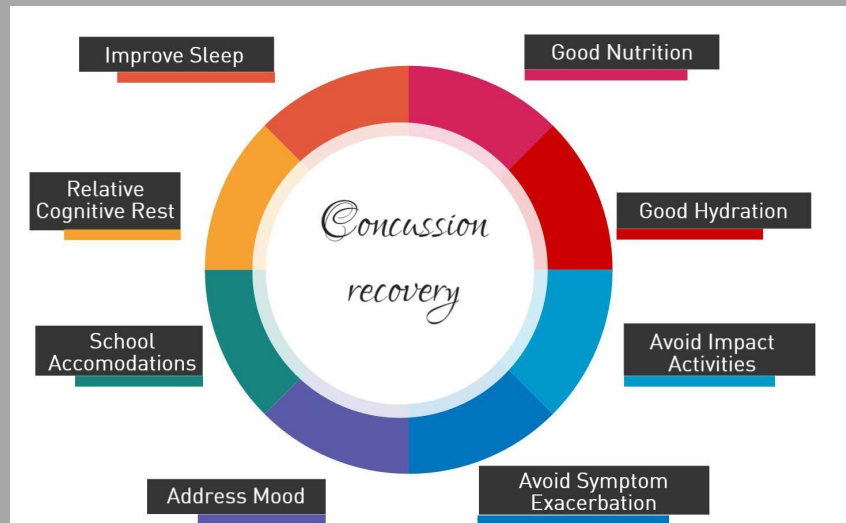
TREATMENT

- Remove from play
- Must individualize
- Return to learn protocol
 - Accommodations
- Return to play protocol – once symptom free
 - Physical rest
 - Cognitive rest
- Treatment of sequelae
 - Pain relief
 - Sleep improvement
 - Psychological treatment



CONCUSSION MANAGEMENT

PREVENT INJURY & DECREASE SYMPTOM BURDEN



Reproduced from Dr Agesen presentation – University of Michigan



GOLD STANDARD TREATMENT

Prevention



WHAT CAN WE DO?

- Take every injury to the head seriously
- Take every precaution to prevent injuries
 - Safe techniques in practice and play
- Encourage recognition and reporting of symptoms
- Seek additional, more specialized care if necessary

- Aid patients/students in recovery
- As you know your students consider investigation is you note changes in communication, personality, behavior, cognitive behavior, etc



NO PAIN NO GAIN!

- Pressure from coaches
- Pressure from teammates
- Pressure from family members
- Pressure from self



SECOND IMPACT SYNDROME

- Repetitive concussion
- An injury soon after a concussion increases the likelihood of experiencing a repeated concussion
- The risk of sustaining a concussion is increased in those who have a history of previous concussion

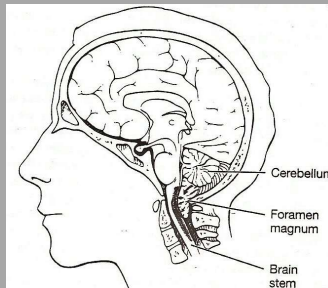
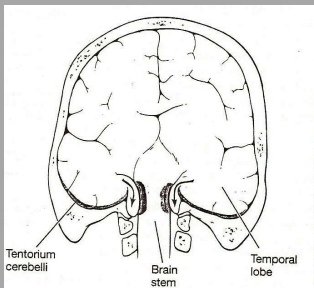
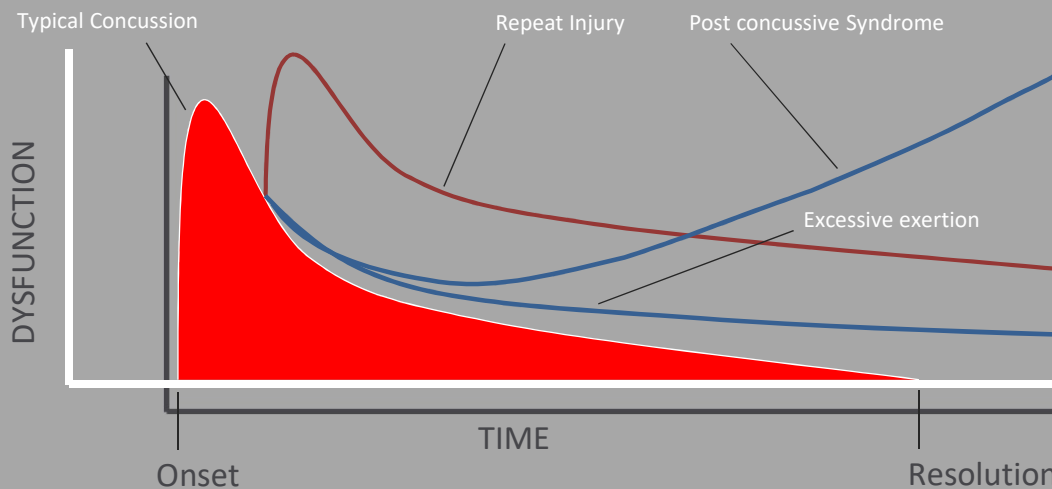


Figure 1. In second impact syndrome, vascular engorgement within the cranium increases intracranial pressure, leading to herniation of the uncus of the temporal lobes (arrows) below the tentorium in this frontal section (a), or to herniation of the cerebellar tonsils (arrows) through the foramen magnum in this midsagittal section (b). These changes compromise the brain stem, and coma and respiratory failure rapidly develop. The shaded areas of the brain stem represent the areas of compression.





CONCUSSION AND CTE

- Concussion and post concussive syndrome - temporary states of neuronal and axonal derangement
- Chronic traumatic encephalopathy - a progressive neurodegeneration that is triggered by repetitive mild TBI, including concussion and subconcussive blows, but evolves slowly over decades in genetically susceptible individuals. Symptoms are not usually apparent until many years later
- Repetitive neuronal and axonal disturbance superimposed on unresolved injury - initiates a series of metabolic, ionic, membrane, and cytoskeletal disturbances that trigger the pathological cascade that leads to CTE
- Definitive diagnosis only by direct tissue analysis



PRINCIPAL OF EARLY DETECTION

- Complete recovery is the goal
- Sound medical judgement must prevail
- If a patient reports or is suspected of having head injury and you notice abnormal actions, sensorium or psychological status intervene



THINGS TO WALK AWAY WITH

- All concussions are serious
 - Don't hide it
 - Report it
 - Take time to recover



SUMMARY

- Sport-related concussions are COMMON
- A concussion is a brain injury
- Symptoms last on average 7 to 14 days but can last weeks to months
- Assessment of concussed athlete is multi tiered
- Diagnosis is based on clinical examination by experienced health care professional
- Treatment must include physical and cognitive rest until asymptomatic – Follow Return To Play Protocol



THE BOTTOM LINE

- Educate the public and raise awareness
- Identify potential injuries that could cause mTBI
- Protect athletes with proper equipment
- Seek medical help as soon as symptoms or concerns occur



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