The Science of Concussion as it Pertains to Children and Youth

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BEARS
U.S. COAST GUARD ACADEMY


NFL PLAYERS
ASSOCIATION


Yankees


NEW ENGLAND
BLACK WOLVES

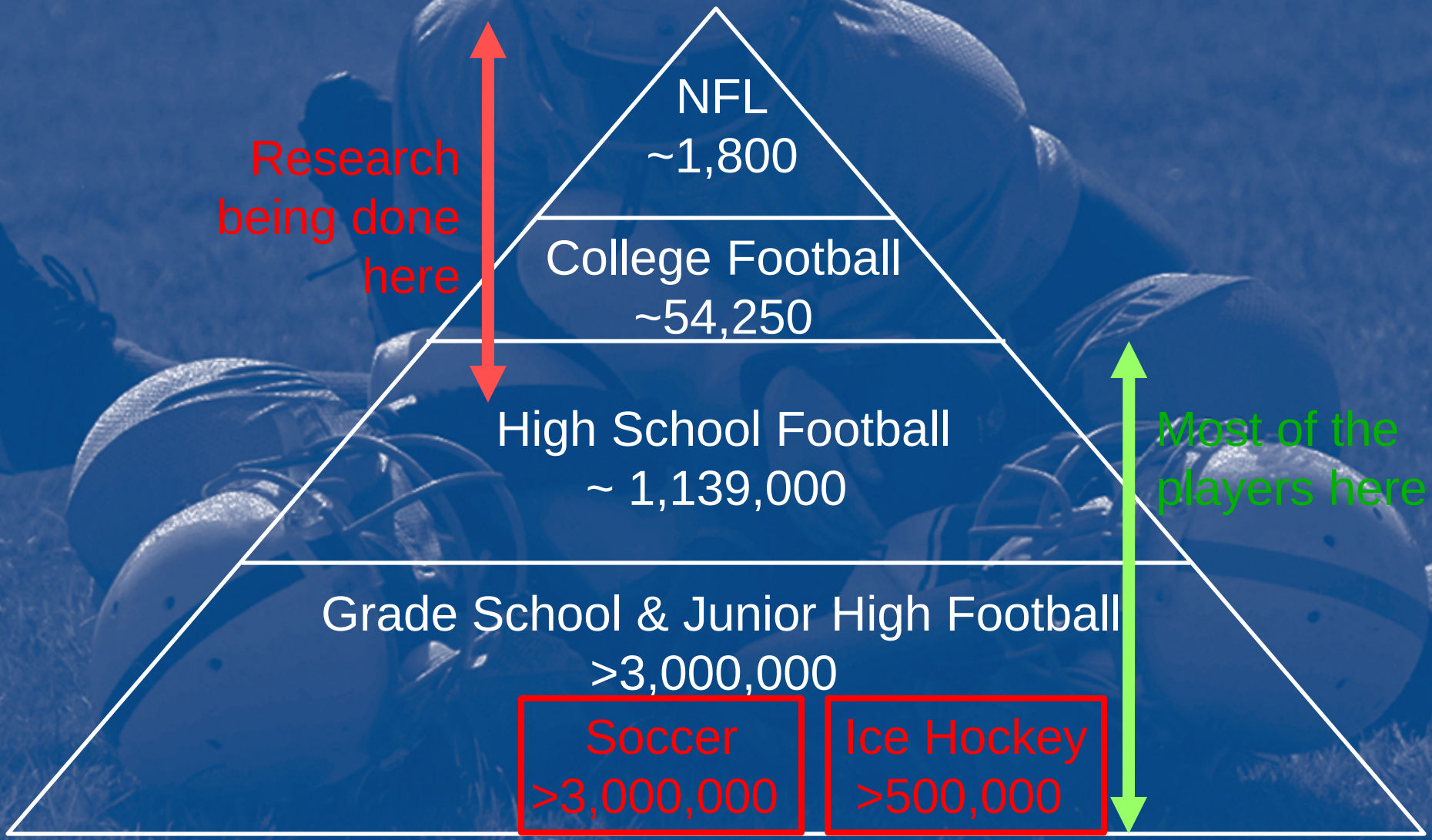

CONNECTICUT
Sun


THE MOHEGAN TRIBE
MUNDU WIGO


CONNECTICUT
1903
QUI TRANSTULIT SUSTINET
STATE POLICE


Mashantucket Pequot
Tribal Nation

The FACTS - Sports

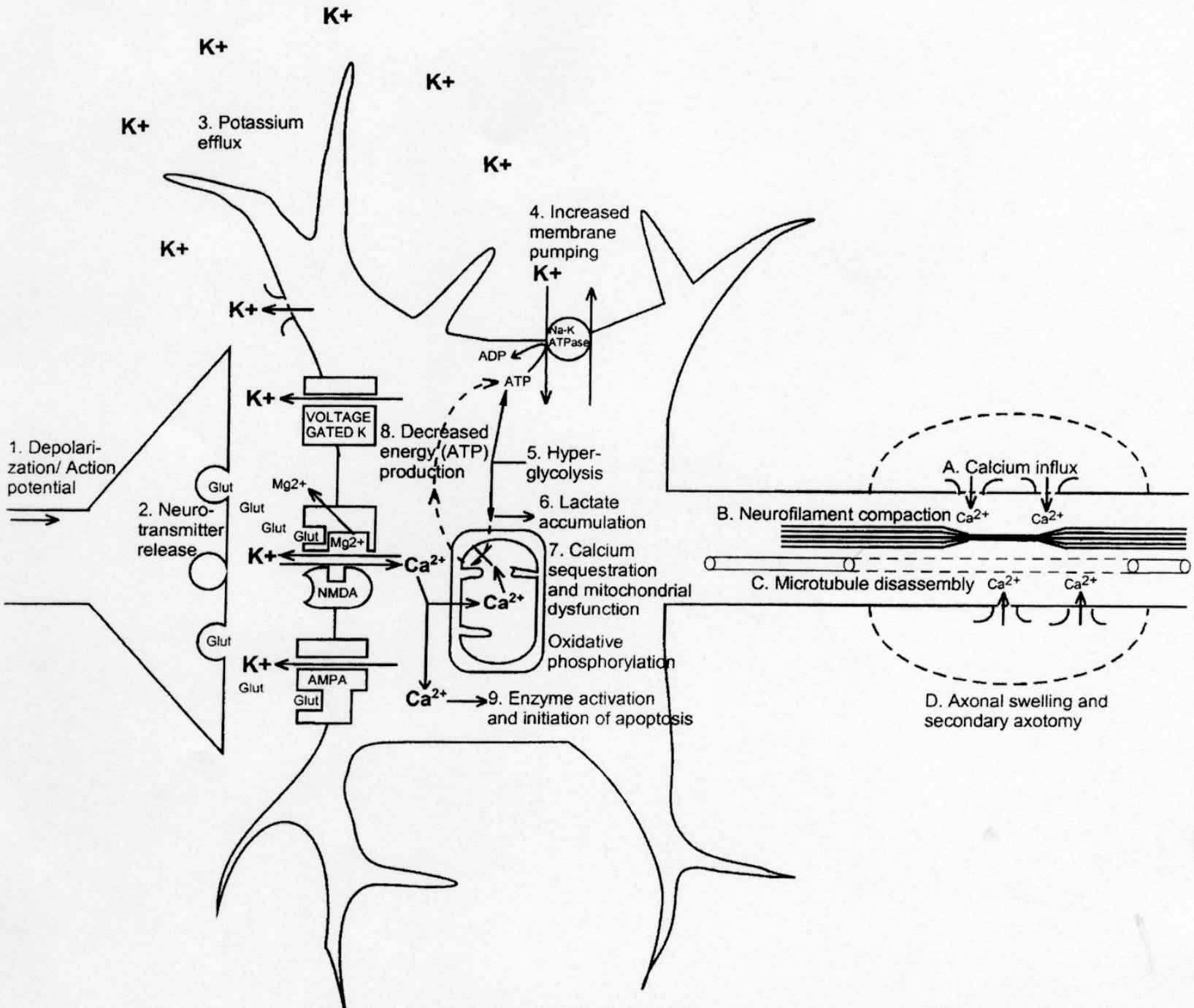


Concussion Defined

- A complex pathophysiological process affecting the brain, induced by biomechanical forces
- physiologic dysfunction without significant anatomic disruption
- most mild of spectrum of TBI

Biomechanics

- rapid deceleration
- sequential acceleration-deceleration
- rotation
- deformation


K+
K+
K+
K+
3. Potassium efflux
K+
K+
4. Increased membrane pumping
K+
K+
Na-K ATPase
ADP
ATP
K+
VOLTAGE GATED K
8. Decreased energy (ATP) production
5. Hyper-glycolysis
1. Depolari-zation/ Action potential
Glut
Mg2+
Glut
Glut
Glut
Mg2+
2. Neuro-transmitter release
6. Lactate accumulation
K+
Ca2+
NMDA
Ca2+
7. Calcium sequestration and mitochondrial dysfunction
Glut
Oxidative phosphorylation
K+
AMPA
Glut
Glut
Ca2+
9. Enzyme activation and initiation of apoptosis
A. Calcium influx
Ca2+
Ca2+
B. Neurofilament compaction
C. Microtubule disassembly
Ca2+
Ca2+
D. Axonal swelling and secondary axotomy

Consequences

- Post Concussive Syndrome
  - headache
  - depression
  - prolonged mild neuropsychological effects
  - susceptibility to repeat concussions
- Second Impact Syndrome
  - second brain injury before the brain has a chance to recover
  - brain swelling, permanent damage and possible death

Chronic Traumatic Encephalopathy (CTE)

- 1928 Dr. Harrison Martland
  "Dementia Pugilistica"
- 2007 Dr. Omalu
- 2009 Dr. Ann McKee
  "Chronic Traumatic Encephalopathy in Athletes"
- 3 professional athletes

CTE

CLINICAL

- Memory disturbances
- Behavioral and personality changes
- Parkinsonism
- Speech and gait abnormalities

PATHOLOGICAL

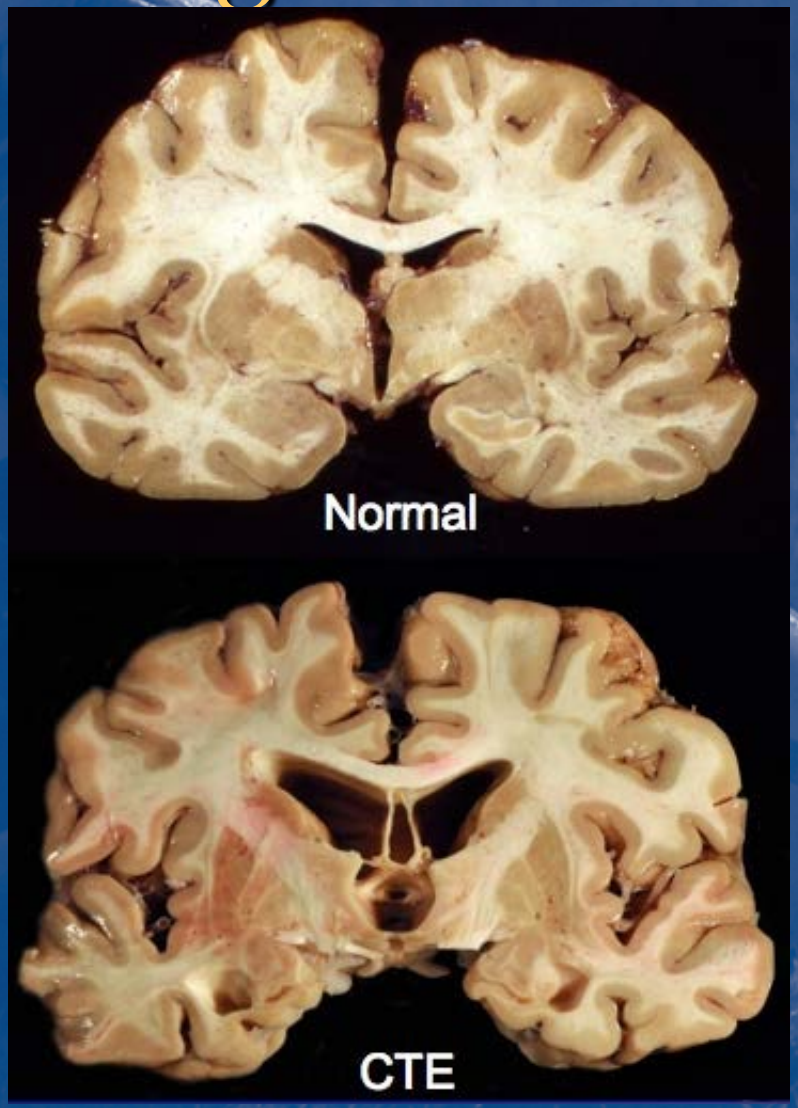
- Atrophy of cerebral hemispheres, medial temporal lobe, thalamus, mammillary bodies, brainstem
- Ventricular dilatation and a fenestrated cavum septum pellucidum

Tau Protein

- Extensive tau immunoreactive tangles
- Preferential involvement of the superficial cortical layers, frontal and temporal cortices
- Prominent perivascular, periventricular and subpial distribution
- Beta-amyloid less prominent

CTE Challenges

- Post-mortem diagnosis
- Only one group studied
- “Association does not necessarily mean causation”
- Subconcussive blows



Chronic Traumatic Encephalopathy

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- 3 professional athletes: 1 football player and 2 boxers

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Special Concerns

- Children
- Athletes with ADHD, migraine, depression, learning disabilities, sleep disorders
- Female athletes

Children

- High levels of participation
- Limited medical training of coaches
- No on-site medical care
- Requires age-appropriate evaluation
- Longer recovery

Medical conditions

- Availability of a medical history is crucial- HIPAA concerns
- Challenge of sorting symptoms of concussion versus pre-existing condition
- Amplified symptom severity
- Longer recovery

Female Athletes

- Participation of female athletes is rising
- Soccer, cheerleading, lacrosse
- Higher mortality
- Longer recovery
- Persistent symptoms

AAN Evidenced-Based Guideline

- Review of medical literature from 1955 to 2012
- Multidisciplinary panel: neurologists, psychologists, physiatrists, athletic trainers
- 13,499 titles and abstracts, 577 full length papers
- For athletes with concussion, what interventions enhance recovery, reduce the risk of recurrent concussion, or diminish long-term sequelae?

AAN Evidenced-Based Guideline

- Presence of experienced licensed health care professional improved early recognition and recovery
- Greatest risk for a second concussion within ten days of the first injury
- Body checking in youth hockey, half visors, quarterbacks, artificial turf result in prolonged recovery

AAN Evidenced-Based Guideline

- Male: football, Australian rugby, hockey
- Female: soccer, basketball

Legislation

- CT Bill No. 456: An Act Concerning Student Athletes and Concussions
- All scholastic coaches must receive instruction on recognizing concussion
- Once identified an athlete must be removed from the contest
- Return to activity only with written certification

Legislation

- Currently laws in 50 states
- Effectiveness:
  - Utilization from January 2006 to June 2012
  - Comparison 2008-2009 vs 2011-2012
  - States with legislation increase 92% vs no legislation 75%
- Legislation has increased awareness

Gibson JAMA Pediatrics 2015

Zurich 2012

- Decreased emphasis on baseline neurocognitive testing (“At present, there is insufficient evidence to recommend the widespread routine use of NP testing”)
- Greater recognition of the unique challenges of the child patient (Child-SCAT3)
- Increased return-to-activity

NCAA, CATS CONSENSUS

- Pre Season: Full-contact practices limited to 4/week and not consecutive for two-a-days

- In Season: Full-contact practices limited to 2/week and no more than 20 in regular season

American Academy of Pediatrics

- "eliminating tackling from football would probably reduce the incidence of concussions, severe injuries, catastrophic injuries and overall injuries"
- Proposed better supervision rather than elimination of tackling
- Non-tackling leagues

Council on Sports medicine and Fitness. Pediatriics 2015
Bachynski NEJM 2016

Return-to-Play

Table 1. Graduated Return-to-Play Protocol

Rehabilitation Stage	Functional Exercise at Each Stage of Rehabilitation	Objective(s) of Each Stage
1. No activity	Symptom-limited physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming, or stationary cycling, keeping intensity <70% of maximum permitted heart rate; no resistance training	Increase heart rate
3. Sport specific exercise	Skating drills in ice hockey, running drills in soccer; no head-impact activities	Add movement
4. Noncontact training drills	Progression to more complex training drills, eg, passing drills in football and ice hockey; may start progressive resistance training	Exercise, coordination, and cognitive load
5. Full-contact practice	After medical clearance, participation in normal training activities	Restore confidence and assessment of functional skills by coaching staff
Return to play	Normal game play	

Treatment of Concussion

- Immediately eliminate potential further harm
- Medical evaluation
- Rest
  - No computer, texting, video games, reading, physical exertion,
- Early recognition is the best treatment

Prevention

- Equipment
  - Properly fit helmet
  - Mouth guards have not been proven to prevent concussion but do avoid dental injuries
- Technique
- Neck strengthening

Questions

- At what age should athletes begin participation in high-velocity collision sports?
- How long does it take for a concussion to resolve?
- How to best prevent concussion?
  - Equipment
  - Rules
  - Legislation
  - Education

Questions

- Treatment?
  - Supplements
  - Light therapy
  - Rest

UConn NeuroSport

- Multidisciplinary approach to neurologic conditions in sports
  - Migraine, epilepsy, multiple sclerosis
  - Special needs
- Concussion
  - Education program focused on scholastic and youth levels
  - Sports neurology fellowship
  - Athletic training symposium

Uconn NeuroSport Concussion Education Project

- Focus on high school athletes, coaches, parents, teachers
- Inner-city schools
- Video presentation for athletes
- Multi-lingual media presentations
- Tracking the effectiveness through testing and recording of reported concussions

Next Steps

- Funding for programs like UConn NeuroSport
  - Longitudinal studies
  - NFLPA example
- Revision of CT General Statutes Sec 20-65f regarding the scope of practice for certified athletic trainers

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