The Science of Concussion as it Pertains to Children and Youth

Anthony G. Alessi, M.D.
Associate Clinical Professor of Neurology and Orthopaedics
Director, UConn NeuroSport
The FACTS - Sports

NFL ~1,800
College Football ~54,250
High School Football ~ 1,139,000
Grade School & Junior High Football >3,000,000

Research being done here
Most of the players here

Soccer >3,000,000
Ice Hockey >500,000
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

Source: Neurosurg Focus © 2008 American Association of Neurological Surgeons
1. Depolarization/Action potential
2. Neurotransmitter release
3. Potassium efflux
4. Increased membrane pumping
5. Hyperglycolysis
6. Lactate accumulation
7. Calcium sequestration and mitochondrial dysfunction
8. Decreased energy (ATP) production
9. Enzyme activation and initiation of apoptosis
A. Calcium influx
B. Neurofilament compaction
C. Microtubule disassembly
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
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

- 1928 Dr. Harrison Martland “Dementia Pugilistica”
- 2009 Dr. Ann McKee “Chronic Traumatic Encephalopathy in Athletes”
- 3 professional athletes: 1 football player and 2 boxers
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. Pediatrics 2015
Bachynski NEJM 2016
## Return-to-Play

### Table 1. Graduated Return-to-Play Protocol

<table>
<thead>
<tr>
<th>Rehabilitation Stage</th>
<th>Functional Exercise at Each Stage of Rehabilitation</th>
<th>Objective(s) of Each Stage</th>
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</thead>
<tbody>
<tr>
<td>1. No activity</td>
<td>Symptom-limited physical and cognitive rest</td>
<td>Recovery</td>
</tr>
<tr>
<td>2. Light aerobic exercise</td>
<td>Walking, swimming, or stationary cycling, keeping intensity &lt;70% of maximum permitted heart rate; no resistance training</td>
<td>Increase heart rate</td>
</tr>
<tr>
<td>3. Sport specific exercise</td>
<td>Skating drills in ice hockey, running drills in soccer; no head-impact activities</td>
<td>Add movement</td>
</tr>
<tr>
<td>4. Noncontact training drills</td>
<td>Progression to more complex training drills, eg, passing drills in football and ice hockey; may start progressive resistance training</td>
<td>Exercise, coordination, and cognitive load</td>
</tr>
<tr>
<td>5. Full-contact practice</td>
<td>After medical clearance, participation in normal training activities</td>
<td>Restore confidence and assessment of functional skills by coaching staff</td>
</tr>
<tr>
<td>Return to play</td>
<td>Normal game play</td>
<td></td>
</tr>
</tbody>
</table>
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
agalessi@uchc.edu
dralessi@twitter.com
Facebook: Anthony G Alessi MD
Website: www.alessimd.com
Telephone: 860-889-3227