Concussion: A tale of many research paths

Sara Chrisman, MD, MPH
Seattle Childrens’ Research Institute
University of Washington
Harborview Injury Prevention and Research Center
Background

- Neuroscience
- Mental Health
- Pediatrics
- Adolescent Medicine
- Master’s in Public Health
- Research on concussion
Our team

- Frederick P. Rivara, MD, MPH
- Emily Kroshus, ScD, MPH
- Christine Mac Donald, PhD
- Carolyn McCarty, PhD
- Stan Herring, MD
- David Coppel, PhD
- Sam Browd, MD, PhD
- Monica Vavilala, MD
- Beth Ebel, MD, MPH
- Nathalia Jimenez, MD
- Megan Moore, MSW
- Doug Zatzick, MD
- Ali Rowhani-Rahbar, MD, PhD, MPH
- Celeste Quitiquit, MD
- Tom Jinguji, MD
- Monique Burton, MD
- Christina Schwien, MN, MPH
- Laura Alonso Gonzalez, BA
- Albert Hsu, BA
- Lauren Fay, BS
- Shannon Higgins, ATC
- Teah Hoopes, BS
- Rebecca Parrish, MS, LMFT
- Suzanne Peck, BA
Our Mission
• To reduce the impact of injury and violence on people’s lives through research, education, training and public awareness.

What We Do
• Track the type, causes, treatment and consequences of injuries
• Use epidemiological tools to identify risk factors for injury
• Develop and evaluate new injury-prevention programs, using behavior change, community education, government action, and product environment modification
• Use the principles of biomechanics to study injury causes and treatment
• Develop more effective ways to resuscitate and treat injury victims
• Improve rehabilitation strategies by identifying injury-related disability and long-term effects
• Train new investigators in injury research
• Educate health professionals, policy makers, and the public about trauma’s magnitude, costs, and prevention
Our research

- Etiology
- Epidemiology
- Treatment & Prevention
Haddon’s matrix

<table>
<thead>
<tr>
<th></th>
<th>Host</th>
<th>Equipment</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Physical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Social</td>
</tr>
</tbody>
</table>

- **Pre-Event**
- **Event**
- **Post-Event**
### Haddon’s matrix for concussion

<table>
<thead>
<tr>
<th></th>
<th>Host</th>
<th>Vector</th>
<th>Physical environment</th>
<th>Social environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-event</strong></td>
<td>• Sport choice</td>
<td>• Aggressivity/ Fair play</td>
<td>• Design of helmets or protective equipment</td>
<td>• Culture of sport regarding aggressivity</td>
</tr>
<tr>
<td></td>
<td>• League choice</td>
<td>• Rules regarding illegal collisions</td>
<td>• Field or ground conditions</td>
<td>• Decreasing collisions</td>
</tr>
<tr>
<td></td>
<td>• Concussion education</td>
<td>• Design of softer balls for younger players</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Event</strong></td>
<td>• Wearing helmets or protective gear</td>
<td>• Enforcement of rules</td>
<td>• Maintaining/rehabbing helmets</td>
<td>• Enforcing of rules and restrictions</td>
</tr>
<tr>
<td></td>
<td>• Neck strengthening</td>
<td>• Use of softer balls for younger players</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safer tackling styles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Post-event</strong></td>
<td>• Reporting of concussion symptoms</td>
<td>• Suspensions/fines for illegal collisions</td>
<td>• Athletic trainer or other medical professionals on the sideline</td>
<td>• Concussion legislation</td>
</tr>
<tr>
<td></td>
<td>• Retirement from sport after multiple concussions</td>
<td></td>
<td>• Standardized assessments</td>
<td>• Culture of sport regarding playing through injury</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Physician training about concussion management</td>
<td>• Consensus guidelines for concussion management</td>
</tr>
</tbody>
</table>
Social-Ecological Model

Increasing responsibility for child sport injury prevention

Government
Sports Organizations
Coach Teacher
Parent
Child


Bronfenbrenner 1977
Research Path 1

- Qualitative focus group study of concussion reporting
- Concussion law implementation
- Coach concussion education (the coach matters)
- Relationships between coaches and medical staff matter
Barriers to concussion reporting
Chrisman et al. 2013

• Football, Girls’ soccer, Boys’ soccer
• Had very good concussion knowledge, but most would still play with concussion symptoms (given a scenario)
• Lots of barriers (they want to play, concussion is non-specific, etc) but coach norms seemed to be the most important factor
Coach norms

• **Football player:** “The coaches call you bad words if you come out. They say ‘when you’re hurt, come out,’ but they don’t mean it. If you say anything they just call you a wuss and tell you you’re overreacting and that you can play through it.”

• **Female soccer player:** “My coach doesn’t want us to play when injured, but I kind of feel pressured because they will say. ‘Well are you sure, do you have to sit out, can you not push through it?’”

• **Female soccer player:** “Some of it is like, you’re being judged. Ever since I started club soccer, my coach is always like, ‘You’re fine.’ I mean like, rec soccer players when you’re younger they’re like little kids will just cry over anything so it was pounded into us like, ‘Suck it up. You’ll be fine if you get knocked a little bit.’ So we didn’t really know when to draw the line.”

• **Football player:** “Coach said if he had to come out there and get you off the field there better be a bone sticking out.”
Coach norms

• **Football player:** “They always give us a little practice and we have to spend a whole day just learning concussions, learning how to hit right and stuff. That is why earlier we were saying that if we feel dizzy we are supposed to tell them.”

• **Female soccer player:** “I think that from previous incidents that I’ve known what our coach expects of us. I’d tell him right away because I know what he wants us to do with injuries, because I’ve been out for a long time.”
Concussion law implementation
Rivara et al. 2014

- Washington state
- 778 athletes (football, girls’ soccer) from 20 high schools
- 10-11% of athletes in both sports had suspected concussion during one season
- 69% played with symptoms
- All received some type of concussion education
- There was no association between concussion reporting and intensity of education
Pac-12

• Working with coaches to help them understand their influence in concussion safety regarding:
  1. Encouraging athletes to report symptoms
  2. Supporting medical staff decisions regarding concussion
Youth who had a concussion have a higher rate of depression

Youth with persistent concussion symptoms have significant mental health symptoms

Subthreshold exercise programs (STEP) seems to help these youth

Hypothesis: STEP is helping by acting as exposure therapy
STEP--Theory

- Concussive injury disrupts cerebral autoregulation
- Systemic blood pressure is communicated to the brain, causing symptoms with exercise
- Rehabilitation can occur by challenging the body with exercise, at a sub-symptom level
- Modeled after John Leddy’s exercise intervention for adults
STEP--background

- Clinical program at Seattle Children’s Hospital
- We completed a chart review (~100 pts), nearly all improved
- But concussion is an injury, expect people to improve
- Next step—recreate STEP in the research lab, conduct an RCT
Pilot STEP RCT

- N=30, 55% female, age mean 15.6 years SD 1.6
- Randomized to 6 week intervention
  - STEP + stretching
  - Stretching alone
- Outcomes (0, 6 week, 3 month, 6 month):
  - Concussive symptoms (weekly during intervention)
  - Accelerometry (MVPA, 0 and 6 weeks)
  - Peds QL
  - Mental health measures
- STEP:
  - completed Balke treadmill test
  - recommended exercise 5-10 minutes > baseline MVPA at 80% of threshold HR
Change in MVPA

[Box plot diagram showing comparison between Control and Intervention groups for pre and post MVPA/day]
Change in concussive symptoms

![Graph showing the change in HBI Total over weeks for Control and Treatment groups.]
Change in Fear-avoidance
NCAA & DoD Grand Alliance

• Jointly funded

• Initial performance period of 3 years

• Two components:
  – Concussion research initiative
    – CARE Consortium
  – Educational “grand challenge”
    – Change the culture around concussion
Aims of the CARE Consortium

1. Establish a national sports related concussion research network

2. Implement largest study to date of natural history of sports-related concussion

3. Implement largest study to date of neurobiological factors of sports concussion
CSC Measures

- Demographics, Personal and Family History
- **ImpACT/Axon/ANAM/CNS** (neurocognitive test that measures ability to remember words and shapes and solve simple problems)
- **SAC** (Standard Assessment Concussion)
- **BESS** (Balance Error Scoring System)
- **SCAT3** (questions about symptoms, e.g., headache, nausea, fatigue, etc.)
- **BSI-18** (measures psychological distress in primary care settings)
- Information on Injury and Return to Activity
- **SF-12** (health related quality of life)
- **SWLS** (life satisfaction in various age groups)
Current Recruitment/Enrollment

- By Fall 2016, **30** performance sites will be actively engaged in the CARE Consortium.

- Exceeded enrollment projections for March 2016.

<table>
<thead>
<tr>
<th></th>
<th>Enrolled</th>
<th>Concussions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC</td>
<td>18,370</td>
<td>939</td>
</tr>
<tr>
<td>ARC</td>
<td>519</td>
<td>43</td>
</tr>
</tbody>
</table>

---

NCAA•DOD
Grand Alliance CARE Consortium
Thank you!

sara.chrisman@seattlechildrens.org
@beyondconcussed
CSC Longitudinal Study: Assessment Time Points

- Baseline + 5 additional time points:

<table>
<thead>
<tr>
<th></th>
<th>PRE-SEASON</th>
<th>ACUTE CONCUSSION</th>
<th>SUB-ACUTE CONCUSSION</th>
<th>POST-CONCUSSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Study Core (CSC)</td>
<td>Baseline</td>
<td>&lt;6hrs Post-Injury</td>
<td>24-48hrs Post-Injury</td>
<td>Asymptomatic/Cleared for Return to Play Progression</td>
</tr>
<tr>
<td>Advanced Research Core (ARC)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
## ARC Assessments

<table>
<thead>
<tr>
<th></th>
<th>Pre-Season</th>
<th>Acute Concussion</th>
<th>Sub-Acute Concussion</th>
<th>Post-Concussion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Neurocognitive and Behavioral Testing (CSC)</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Blood Biomarker &amp; DNA Collection</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Multi-modal MRI Studies</strong></td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

- Neurocognitive and Behavioral Testing (CSC): X
- Blood Biomarker & DNA Collection*: X
- Multi-modal MRI Studies: X

---

*Note: Some assessments may require additional testing or monitoring based on individual needs and medical history.*

---

NCAA•DOD
Grand Alliance CARE Consortium
Fear-Avoidance

Vlayen and Linton 2000