Concussions: What You Need to Know!

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General Pediatrician with special training in Pediatric Sports Medicine

Medical Director: Eastern Ontario Concussion Clinic (EOCC) and Pediatric Sports Medicine Clinic of Ottawa (PSMCO)
A Little About Me

- Son of a Hockey Coach
- Played Junior Hockey in Ottawa Area
- Recruited to play University Hockey
- Pediatric Residency at the Univ of New Mexico
- Sports Medicine Fellowship at Harvard
• I was the head doctor for the Northeastern Men’s Varsity Hockey Team
• Worked with the New Mexico Scorpions (CHL) and many high school programs
• I have given talks at the local, state & national level
• 1 of approximately 5 Pediatric trained Sports Medicine Physicians in the Country
• 1 of only a few Healthcare Providers in the country with the designation of a “Certified IMPACT Consult”
Objectives

• To briefly define what a concussion is
• To explain the underlying Pathophysiology/Biomechanics
• To describe the epidemiology
• To outline symptoms
• Explain the Hype (CTE, SIS)
• Prevention
DEFINITIONS

- *Concussion* is defined as

“a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces”

Concussion = Force =

“Mass x Acceleration”

Common Themes Of Concussions

1. Short-lived.
   • Indeed 90% of athletes are symptom-free within 10 days.

2. Functional disturbance NOT a structural injury.

3. +/- LOC. Resolution typically follows a sequential course; symptoms may be prolonged.
4. May be caused either by a direct blow to the head, face, neck or elsewhere on the body with an “impulsive” force transmitted to the head.

5. Occurs with head injury due to contact and/or acceleration/deceleration forces. (McCrory et al 2009).

Biomechanics - Acceleration required

• In 1941 Denny-Brown:
• Used a pendulum to hit cats and dogs in the skull.
• They found you need head movement to cause a concussion

• Denny-Brown, D Brain (1941) 64:93-164
Rotational vs Linear Acceleration

- Ommaya and Gennarelli (1974)

- Rotational acceleration is more closely linked to concussion than straight back and forth

Symptoms attributed to

- A combination of *cellular ionic disturbances*, *decreased CBF*, *Amino Acid abnormalities*, and *glucose metabolic dysfunction*

- **CAUSING AXONAL DAMAGE**
EPIDEMIOLOGY: How big a problem is this?

- Up to 3.8 million of concussions occur annually as a direct result of participation in athletics.

- High Risk vs Low Risk Sports.

- An accurate number is difficult to estimate.


** Delaney JS; Abuzeyad F; Correa JA; Foxford R Recognition and characteristics of concussions in the emergency department population. AUDelaney JS; Abuzeyad F; Correa JA; Foxford R SOJ Emerg Med 2005 Aug;29(2):189-97


Concussion Incidence in 8 Contact Sports

- A Metanalysis of 23 studies found Hockey had the greatest incidence of concussions in male athletes

- 3.6/1000 athlete exposures

In the ODHA

- 20,000 Kids
- 4 hours/week
- 28 weeks

= 8060 concussions/yr
Signs and Symptoms

- Symptoms of sport-related concussion can be grouped into 4 general categories:

  1. Sleep disturbance
  2. Somatic (headache)
  3. Emotional
  4. Cognitive

Signs and Symptoms

- The hallmarks of concussion are confusion and amnesia, often without preceding LOC*

- In fact the majority of concussions in sports occur without LOC (80%) and are often unrecognized**

- Symptoms may not be apparent until hours later


** Collins MW; Grindel SH; Lovell MR; Dede DE; Moser DJ; Phalin BR; Nogle S; Wasik M; Cordry D; Daugherty KM; Sears SF; Nicolette G; Indelicato P; McKeag DB Relationship between concussion and neuropsychological performance in college football players. JAMA 1999 Sep 8;282(10):964-70
Signs/Symptoms

- Amnesia, retrograde or antegrade
- Disorientation
- Appearing dazed
- Acting confused
- Forgetting game rules or play assignments
- Inability to recall score or opponent
- Inappropriate emotionality
- Physical incoordination
- Imbalance
- Seizure
- Slow verbal responses
- Personality changes

- Headache
- Dizziness
- Nausea or vomiting
- Difficulty balancing
- Vision changes
- Photophobia
- Phonophobia
- Feeling “out of it”
- Difficulty concentrating
- Tinnitus
- Drowsiness
- Sadness
- Hallucinations
- None initially

“Just doesn’t seem right”
• WHY DOES PROCEEDING WITH CAUTION REALLY MATTER?
Differential Diagnosis for an Acute Head Injury

- Concussion
- Post Traumatic Headache
- Subdural hematoma
- Epidural hematoma
- Intraparenchymal hemorrhage
- Second Impact Syndrome
- Cervical spine injury
- Seizure/epilepsy
Repeat Insult

- A repeated head injury can result in a prolonged period of PCS (CROSBY) and have more deleterious consequences (SIS).
Second Impact Syndrome

• “Rapid and progressive brain injury resulting from a second episode of closed-head injury while the athlete still is symptomatic from the first episode.” (Saunders and Harbough 1984)
SIS

- The result is rapid mental deterioration, mental status change, and often fatal uncal herniation.
- SIS is associated with a mortality rate of 70%-80%
- Completely preventable through the prompt recognition of concussive and PCS
- Signifies the need for close monitoring

In the Short term (What I tell players)

- If you’re concussed:
  - Reaction time increased
  - Processing time is increased
  - Memory Impaired
  - More prone for another concussion
1. “You’re not doing yourself or your teammates any favours”

2. “Better to miss another game then the season”

3. “When in Doubt ........Sit it Out”
Long Term Effects

• Approximately 225,000 new patients each year show long-term deficits from mild TBI,
  ▫ approximately = to the # of patients diagnosed annually with breast cancer, multiple sclerosis, and traumatic spinal cord injury combined

Potential Long Term Effects:

1) Alzheimer’s
2) Learning disability
3) Decreased attention
4) ALS
5) Parkinson’s
6) Dementia
7) Second impact syndrome
8) More severe concussions
9) Personality change
10) CTE
11) Depression
12) Persistence of any acute symptom
Multiple Concussions

- Collins et al 1999
  - demonstrated long term mild deficits in executive function with those who suffered more than 2 concussions
  - No definitive consensus on the relationship between the number of concussions and persistent cognitive impairment

- 2003 JAMA Guskiewicz et al
  - ≥3 concussions = 3x more likely to have another concussion
  - ≥3 concussions: 30% had symptoms > 1 week

- 2004 Brain Injury Iverson et al
  - ≥3 concussions = more preseason symptoms
  - ≥3 concussions = 7.7x more likely to have memory problems 2 days after injury

- 2005 Neurosurgery Moser et al
  - ≥2 concussions = same neuropsych scores while symptoms free as 1 week post-concussion for first-time concussions

- 2006 BJSM Iverson et al
  - 1-2 concussions versus 0 = no difference on ImPACT
Chronic Traumatic Encephalopathy

- Frequent, diffuse, extracellular amyloid plaques.
- Sparse intraneural neurofibrillary tangles.
- Seen in Alzheimer’s Disease, but in a very distinct distribution (antorhinal cortex/hippocampus).

- Omalu, Neurosurgery 2005, “The NFT distribution is notably different from that observed in normal aging and AD.”
BU’S CTE Program

- *Sports Legacy Institute*
- Created by Dr Robert Cantu and Chris Niwitzky (ex Harvard football player and WWF wrestler)
- Involved in Concussion Research, Education and Advocacy
- Home of the *Brain Bank*
- I am the clinical supervisor of their concussion education program called S.L.I.C.E
Case Studies

- Lou Creekmur
- John Grimsley
- 18 Year-Old (John Doe)
Management

• In their review of Primary Care Physicians Notebaert and Guskiewicz (2005) found that many clinicians don’t have a comprehensive concussion assessment plan.

“The 7 Day Rule”

- Guskiewicz, JAMA 2003, Prospective, 2905 college football players. Prev concussion 3x more likely than no hx.
  - Of in-season repeats, 92% within 10d of each other.
  - Not practical or accurate today
Now in many States, legislation dictates that any child with a concussion cannot return to sports until he is cleared by

- A physician
- A health trained professional
- A health trained professional trained in concussions
Assessment

- Traditionally assessment has been based on
  - +/- LOC
  - Return to activity based on the grade of concussion.

- More recent thinking emphasizes:
  - No longer “concussion grades”
  - stresses physical and cognitive rest;
  - and recommends a sequential, functional progression as symptoms clear and do not return with exertion, with careful monitoring by a physician.

Important considerations in the management of MTBI include

1. Identification of immediate neurologic emergencies
2. Identification of high-risk individuals for SIS
3. Recognition and management of neurologic sequelae
4. Prevention of cumulative and chronic brain injury

On the Sideline

- Westmead post-traumatic amnesia scale (WPTAS)

- Simple to perform, taking less than 1 min in the acute setting, and correlates with the findings in more detailed neuropsychologic testing.


- Ponsford J; Willmott C; Rothwell A; Kelly AM; Nelms R; Ng KT. Use of the Westmead PTA scale to monitor recovery of memory after mild head injury. Brain Inj. 2004 Jun;18(6):603-14
The questions include:
1. What is your name?
2. What is the name of this place?
3. Why are you here?
4. What month are we in?
5. What year are we in?
6. In what town/suburb are you in?
7. How old are you?
8. What is your date of birth?
9. What time of day is it? (morning, afternoon, evening)
10. Three pictures are presented for subsequent recall

Any incorrect response is considered a positive test for cognitive impairment after head injury.
Maddocks Questions

✓ Scientifically validated (any incorrect response indicates concussion)
✓ Quick, simple and practical

1. Which field are we at?
2. Which team are we playing today?
3. Who is your opponent at present?
4. Which half/period is it?
5. How far into the half is it?
6. Which side scored the last touchdown/goal/point?
7. Which team did we play last week?
8. Did we win last week?
Several Other Instruments are available:

1. **Sport Concussion Assessment Tool (SCAT)**
   - Medical evaluation and a checklist for the athlete
   - Also provides information about concussions
SCAT 2

Sport Concussion Assessment Tool 2

**Symptom Evaluation**

How do you feel?

Answer yes or no to the following symptoms, based on how you feel now.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>No</th>
<th>Yes</th>
<th>Questionaire</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Loss of balance</td>
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<tr>
<td>Nausea</td>
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<tr>
<td>Vomiting</td>
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<tr>
<td>Blurred vision</td>
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<td></td>
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<tr>
<td>Sensitivity to light</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling like &quot;drunk&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Sport hangover&quot;</td>
<td></td>
<td></td>
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<tr>
<td>Difficulty concentrating</td>
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<tr>
<td>Difficulty remembering</td>
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<td></td>
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<tr>
<td>Pale or grayish skin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tinnitus</td>
<td></td>
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<tr>
<td>Dizziness</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Nears or Amnesia</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Total number of symptoms (maximum possible)</strong></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

**Symptom severity scores**

1. Pain does not bother me at all
2. Pain bother me
3. Pain bothered me very much
4. Pain bothered me to the point of a no activity

**General note:**

If you choose yes on any questions, please answer the following question: Do the symptoms get worse with mental activity? (Yes/No)

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**Cognitive & Physical Evaluation**

**Cognitive assessment**

**Standardized Assessment of Concussion (SAC)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
</tr>
</thead>
</table>
| **Memory**
| 1. Repeat a list of 3 words |       |
| 2. Repeat a list of 3 words |       |
| 3. Repeat a list of 3 words |       |
| 4. Repeat a list of 3 words |       |
| 5. Repeat a list of 3 words |       |
| **Attention**
| 1. Concentrate on a word |       |
| 2. Concentrate on a word |       |
| 3. Concentrate on a word |       |
| 4. Concentrate on a word |       |
| 5. Concentrate on a word |       |
| **Language**
| 1. Repeat a sentence |       |
| 2. Repeat a sentence |       |
| 3. Repeat a sentence |       |
| 4. Repeat a sentence |       |
| 5. Repeat a sentence |       |
| **Motor skills**
| 1. Finger blur test (left hand) |       |
| 2. Finger blur test (right hand) |       |
| 3. Finger blur test (left hand) |       |
| 4. Finger blur test (right hand) |       |
| 5. Finger blur test (left hand) |       |
| **Total score** |       |

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**Clinical evaluation**

- **Motor skills**
  - Finger blur test (left hand)
  - Finger blur test (right hand)
  - Finger blur test (left hand)
  - Finger blur test (right hand)
  - Finger blur test (left hand)

**Total score**

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**Concussion**

- **Symptoms**
  - Headache
  - Nausea
  - Vomiting
  - Blurred vision
  - Sensitivity to light
  - Sensitivity to noise
  - Feeling slowed down
  - Feeling like "drunk"
  - "Sport hangover"
  - Difficulty concentrating
  - Difficulty remembering
  - Pale or grayish skin
  - Tinnitus
  - Dizziness
  - Nears or Amnesia

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**Recovery**

- **Rest**
  - Avoid physical activity
  - Avoid mentally demanding activities

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**Contact your doctor or health professional**

- If symptoms persist or worsen, seek medical attention.

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**Follow-up**

- Schedule a follow-up appointment with your doctor or health professional.

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**Conclusion**

- **Physical signs**
  - No physical signs identified.
  - No abnormality noted.
  - No signs of injury.

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**Notes**

- **Note:**
  - Any changes or improvements should be reported immediately.
  - If symptoms persist or worsen, seek medical attention.

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**Additional resources**

- **Website:**
  - SCAT.org
  - Concussion.org

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**Disclaimer**

- The information provided is for educational purposes only and should not replace professional medical advice.
Other Warning Signs

- The following warning signs should prompt the caregiver to seek immediate medical help:

  1. Inability to awaken the patient
  2. Severe or worsening headaches
  3. Somnolence or confusion
  4. Restlessness, unsteadiness, or seizures
  5. Difficulties with vision
  6. Vomiting, fever, or stiff neck
  7. Urinary or bowel incontinence
  8. Weakness or numbness involving any part of the body
If they’re not dieing then what?

- It is now well accepted that any athlete who obtained a concussion does not return to play that day and child/adolescent athletes stay out for at least 7 days.
• Observation is recommended for at least 24 hours after a MTBI because of the risk of intracranial complications.


Recovery

- Between 80-90% of kids get better within 10-14 days.
- I wouldn’t see these kids (3 week- 1 yr)
- Issues arise with preexisting conditions, malingering, secondary gains etc
Factors Influencing Recovery

- Age
- Gender
- History of prior concussion
- Cognitive reserve
- Pre-existing Medical Conditions
NEUROPSYCHOLOGICAL TESTING

• And what I call the IMPACT EPIDEMIC
Why do we need baseline neurocognitive assessments in sports?

- “Nobody in football should be called a genius. A genius is a guy like Norman Einstein.”

  -- Joe Theisman Football commentator and former player

**or just look at twitter comments during NFL lockout**
The use of neuropsyc testing provides an objective data. But how good is that data? Depends who you ask.... They measure domains, such as attention, working memory, visual motor speed, reaction time. Examples include ImPACT, CogSport, Headminder and ANAM (Military)
Downside

- Examiner typically cannot directly observe the athlete taking the test.
- Computer-based tests sample from selective neuropsychological domains rather than a global assessment of cognitive function.
- 30% Sandbag
- Group testing? SHOULD NOT BE DONE IN GROUPS
- Repeat Baselines
- How accurate/reproducible/representative?
- THE TEST SHOULD NEVER BE DONE WHILE STILL HAVING SYMPTOMS

  ▫ The application of neuropsychological (NP) testing in concussion has been shown to be of clinical value and continues to contribute significant information in concussion evaluation

  ▫ should be an important component in any return to play protocol

Personal Bias

- Overused
- Misused—should never be given while a patient is symptomatic (I am saying this again!)
- Must determine if it is a valid test
- Sensitivity issues and reproducibility
- See Work by Randolph
Neuroimaging

- Neuroimaging is usually normal in patients with a concussion or MTBI
- However, there is a defined incidence of abnormalities, which may be clinically important
• Newer Imaging techniques are going to Revolutionize Concussion Care
• You will be able to “see” a concussion
• They are still a few years away to being widely available
Treatment: General Principles

1. Hydrate,
2. Glucose control,
3. Sleep hygiene
4. Limit cognitive and physical stress (with one exception)
Treating The Difficult Concussion

• This is basically all I saw while in Boston
• Athletes from all over the country
• We specific medications for sleep, depression, cognitive difficulties (this is an 1hr talk in of itself)
• Melatonin, amytryptilline, trazadone, methylphenidate, amantidine, SSRI (steroids?)
Concussion and RTP

- JAMA 2003 Guskiewicz et al
  - 75% of same-season repeat concussion occurred <7 days from the first; 92% < 10 days

- It is now widely accepted that it takes kids at least 7 days to fully recover.
## Level of physical activity

<table>
<thead>
<tr>
<th>Step</th>
<th>Level of physical activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No activity, complete rest. Once asymptomatic, proceed to level 2.</td>
</tr>
<tr>
<td>2</td>
<td>Light aerobic exercise such as walking or stationary cycling, no resistance training.</td>
</tr>
<tr>
<td>3</td>
<td>Sport specific exercise - for example, skating in hockey, running in soccer; progressive addition of resistance training at steps 3 or 4.</td>
</tr>
<tr>
<td>4</td>
<td>Non-contact training drills.</td>
</tr>
<tr>
<td>5</td>
<td>Full contact training after medical clearance.</td>
</tr>
<tr>
<td>6</td>
<td>Game play.</td>
</tr>
</tbody>
</table>
Prevention

- The simplest preventative measures are be:
  
  RULE CHANGES, RULE ENFORCEMENT and PLAYER, & COACH EDUCATION
  (Cantu and Mueller 2009)

- **Strengthening neck and back muscles** are the only interventions shown to consistently decrease concussions

Current Issues

- Helmets?
- Visors?
- Mouth guards?
- Age at Which Body Checking Starts?
- Force threshold?
Ways to protect players from obtaining a concussion:

• Be a strong skater- good balance and agility
• Keep your head up
• Be aware
• Always approach the boards on an angle
• Protect yourself with your arms when going into the boards
• Know the danger zone-3-4 feet away from the boards
• Get physically strong especially neck muscles
• +/- mouthgaurd?
Ways to avoid causing concussions:

- Never hit from behind
- Never hit to the head
- Be responsible with your stick
- No suicide passes
- Communicate on the ice
- Respect your opponent
A Child’s Brain is a Child’s Future

Save it!
About The Author:

Dr. Kristain Goulet is a General Pediatrician and 1 of approximately 6 Pediatric trained Sports Medicine Physicians in Canada. He completed his Pediatric Residency at the University of New Mexico and a Pediatric Sports Medicine Fellowship at Harvard University.

“Treating concussions is one of my passions. With up to 4000 concussions occurring annually, there is a huge need for qualified professionals in the Ottawa area. I worked at the Concussion Clinic at the Children’s Hospital Boston which is a national leader in concussion care. I have been taught the most cutting edge treatment modalities in both Concussions and Pediatric Sports Medicine. I am eager to bring my experience to Ottawa.”

Dr Goulet is the medical director for the Eastern Ontario Concussion Clinic (EOCC) and the Pediatric Sports Medicine Clinic of Ottawa (PSMCO).

Additional Information is available at: www.concussioncentre.com. Dr. Goulet can be reached via email at kristiangouletmd@gmail.com
Links for Concussion Information

Required concussion course for Mass Coaches/Staff:
www.nfhslearn.com/electiveDetail.aspx?courseID=15000
www.cdc.gov/Concussion

General concussion informational links:
www.cdc.gov/concussioninyouthsports

For Coaches:

For School Nurses:
www.cdc.gov/concussion/HeadsUp/schools.html

For Athletes/Parents: