Neuropsychiatry of mild Traumatic Brain Injury (mTBI)/Concussion

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– None
Learning Objectives

- To appreciate signs/symptoms of mTBI/concussion
- To understand neuropsychiatric diagnosis and formulation of mTBI/concussion
- To develop an understanding of other neuropsychiatric sequelae of mTBI/concussion
- To develop an approach to management of common neuropsychiatric sequelae of mTBI/concussion
PRE-QUIZ

Concussion/mTBI is a traumatic brain injury.

A. True
B. False
Concussion/mTBI is a traumatic brain injury.

A. True
B. False
PRE-QUIZ

What is the definition of a concussion/mTBI?

A. Loss of consciousness for <5 min after an impact to the head
B. A complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces
C. A structural brain injury caused by mild traumatic force that transiently decreases cerebral blood flow
What is the definition of a concussion/mTBI?

A. Loss of consciousness for <5 min after an impact to the head

B. A complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces

C. A structural brain injury caused by mild traumatic force that transiently decreases cerebral blood flow
A concussion/mTBI be diagnosed on conventional CT or MRI?

A. True
B. False
PRE-QUIZ

A concussion/mTBI be diagnosed on conventional CT or MRI?

A. True

B. False
Which one of the following is correct regarding post-concussive syndrome?

A. Symptoms are always malingered
B. Psychiatric comorbidity can contribute to somatic and cognitive symptoms
C. Persistent concussive symptoms imply a diagnosis of chronic traumatic encephalopathy
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A. Symptoms are always malingered
B. Psychiatric comorbidity can contribute to somatic and cognitive symptoms
C. Persistent concussive symptoms imply a diagnosis of chronic traumatic encephalopathy
WHAT IS A CONCUSSION?

- **Traumatic brain injury** induced by **biomechanical forces**

- Caused either by a **direct blow** to the **head** **OR** elsewhere on the **body** with an impulsive force transmitted to the head

- Results in **rapid onset of short-lived impairment of neurological function** that usually resolves spontaneously

- **Functional disturbance** rather than a structural injury

- Results in a **range of clinical signs and symptoms** that may or **may not** involve loss of consciousness

- In some cases **symptoms may be prolonged**

HOW DOES IT HAPPEN?

• Transmitting forces to the brain
  • Through injury to head, neck or body causing:
    • Sudden acceleration / deceleration forces
      • *No contact injury required*
    • Rotational forces- ie. Boxing

• Generally disturbance of **function** rather than of brain structural injury *

• **NOT** necessarily due to bleeding or bruising in the brain

• **MAY** progress to more severe TBI in acute stage

*McCrory P et al. 2013; Signoretti S et al, 2011*
mTBI versus concussion

• Synonymous acceptance of mTBI and concussion
• However not all mTBI are truly ‘concussive’
• Precise definition and diagnosis problematic:
  • Head injury/concussion/mTBI
    ▪ Possible
    ▪ Probable
    ▪ Definite
  • Complicated mTBI vs Moderate TBI
  • Post-concussive syndrome

Signoretti et al. 2011
### TBI severity classification

#### Sidebar 2: Indicators for Immediate Referral
*(If a patient meets criteria for more than one category of severity, the higher severity level is assigned)*

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Imaging</td>
<td>Normal</td>
<td>Normal or abnormal</td>
<td>Normal or abnormal</td>
</tr>
<tr>
<td>Loss of Consciousness (LOC)</td>
<td>0-30 min</td>
<td>&gt;30 min and &lt;24 hours</td>
<td>&gt;24 hours</td>
</tr>
<tr>
<td>Alteration of Conciousness/ mental state (AOC)*</td>
<td>up to 24 hours</td>
<td>&gt;24 hours; severity based on other criteria</td>
<td></td>
</tr>
<tr>
<td>Posttraumatic Amnesia</td>
<td>0-1 day</td>
<td>&gt;1 and &lt;7 days</td>
<td>&gt;7 days</td>
</tr>
<tr>
<td>Glasgow Coma Scale (GCS) (best available score in 24 hours) **</td>
<td>13-15</td>
<td>9-12</td>
<td>&lt;9</td>
</tr>
</tbody>
</table>

---

**Glasgow Coma Scale (GCS)**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Response</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best eye response</td>
<td>Open spontaneously</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Open to verbal command</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Open to pain</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No eye opening</td>
<td>1</td>
</tr>
<tr>
<td>Best verbal response</td>
<td>Orientated</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Confused</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Inappropriate words</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Incomprehensible sounds</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No verbal response</td>
<td>1</td>
</tr>
<tr>
<td>Best motor response</td>
<td>Obeys commands</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Localising pain</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Withdrawal from pain</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Flexion to pain</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Extension to pain</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No motor response</td>
<td>1</td>
</tr>
</tbody>
</table>

Glasgow Coma Scale and Score (NICE 2003)
Complicated mTBI

• 6-10% of cases, May have:
  • Intracranial hemorrhage (ICH) or contusion on neuroimaging
  • Skull fracture
  • Lower GCS than would be expected
  • Focal neurological signs

• Functional outcomes more similar to moderate TBI patients
• If neurological deterioration of mTBI acutely or subacutely suspect evolving ICH and reassess TBI severity, investigations and management

Broshek et al. 2015
WHO GETS A CONCUSSION/ mTBI?

• Most common form of traumatic brain injury and Neurological disorder
  • 70-90% of all TBI

• Reaching epidemic proportion :
  • ~ 148,000 in Ontario in 2013*

• Many undiagnosed

• Rate of death 0.2 % of those who visit emergency

WHO GETS A CONCUSSION?

• Falls (30-38%)

• MVA (20-40%)

• Occupational (10%)

• Recreational (10%)-Individual risk of 20% per season in contact sports

• Assaults (5-17%)

• MVA more common in young, Falls more common in Elderly

(Feigin et al., 2013; Jennet & Frankovynsi, 1990)
Risk Factors for mTBI/Concussion

- Male
- High-Risk activities
- Lower socioeconomic status
- Lower cognitive reserve
- Substance Use
- ADHD
- History of previous mTBI/Concussion
- Other medical illness
## Signs/Symptoms

<table>
<thead>
<tr>
<th>Cognitive</th>
<th>Emotional</th>
<th>Somatic/Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>Anxiety</td>
<td>Headache</td>
</tr>
<tr>
<td>Concentration</td>
<td>Depressed mood</td>
<td>Dizziness</td>
</tr>
<tr>
<td>Disorientation</td>
<td>Irritability</td>
<td>Fatigue</td>
</tr>
<tr>
<td>Memory</td>
<td>Lability</td>
<td>Sensitivity to light/sound</td>
</tr>
<tr>
<td>Recall</td>
<td>Suicidal thoughts</td>
<td>Tinnitus</td>
</tr>
<tr>
<td>In a ‘Fog’</td>
<td></td>
<td>LOC</td>
</tr>
<tr>
<td>Amnesia</td>
<td></td>
<td>Incoordination</td>
</tr>
<tr>
<td>Executive dysfunction</td>
<td></td>
<td>Visual changes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sleep disturbance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seizures (less than 5% of mild to mod TBI)</td>
</tr>
</tbody>
</table>
## RED FLAGS

**Sidebar 1: Indicators for Immediate Referral**

1. Progressively declining level of consciousness
2. Progressively declining neurological exam (Appendix 3.4)
3. Pupillary asymmetry
4. Seizures
5. Repeated vomiting
6. Neurological deficit: motor or sensory
7. Double vision
8. Worsening headache
9. Cannot recognize people or disoriented to place
10. Slurred speech
11. Unusual behavior

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When to image

In Concussion/mTBI: Neuroimaging is usually unremarkable and not routinely indicated.
Natural History of Recovery

- Disability worse on first 7-14 days

- Symptoms resolve within 1-3 months in most cases

- 15-20% may remain symptomatic beyond 6 months. Termed post-concussive syndrome/persistent post-concussive symptoms
Post-traumatic Headache (PTH)

- Most common mTBI symptom
- Typically improve days-weeks
- Migraine, tension type headaches, mixed & other
- Psychiatric disorders can also contribute to headaches in mTBI

**Exacerbating factors:**
- Stress
- Insomnia
- Lack of Aerobic Exercise
- Skipping Meals
- Dehydration
Post-traumatic Headache

• Beware medication overuse headaches
  • 50% of people with 15+ headaches per month

<table>
<thead>
<tr>
<th>Max Use 10 days per month</th>
<th>Max Use 15 days per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Combination Analgesics (with caffeine/codeine)</td>
<td>-OTC or prescription NSAIDS</td>
</tr>
<tr>
<td>-Triptans</td>
<td>-ASA</td>
</tr>
<tr>
<td></td>
<td>-Acetaminophen</td>
</tr>
</tbody>
</table>

• Avoid Narcotics

• Consider prophylactic therapy if frequent and disabling (Beta-blockers, Antiepileptics, TCA’s, SNRI’s and many others, consider comorbidities to reduce polypharmacy)*
Headache

- Tension/Other vs Migrainous
- OTC
- Prophylactic
- Abortive

GUIDELINE FOR CONCUSSION/MILD TRAUMATIC BRAIN INJURY & PERSISTENT SYMPTOMS.
Sleep Disturbance

- 50% + of mTBI
- Initially hypersomnic
- Insomnia in subacute/chronic
- Poor prognostic factor at 1 year post injury
- Screen for depression, anxiety, PTSD, pain
- Can be driver of subjective cognitive dysfunction, other somatic symptoms in mTBI
mTBI & Sleep Treatment

- Cognitive Behavioral Therapy/Mindfulness
- Melatonin
- Magnesium/Zinc supplementation
- Trazodone
- ‘Z’ class drugs*
- Tricyclic antidepressants*
- Mirtazapine
- Prazosin if PTSD related nightmares
- Avoid Benzodiazepines*
Fatigue in mTBI

• 30% of mTBI
• Multifactorial
  • Insomnia
  • Pain
  • Iatrogenic
    • Ie. Medication
    • Prolonged prescribed rest
  • Cognitive
  • Psychological/Psychiatric
  • Social Stressors
  • Deconditioning*
• If present, poor prognostic factor
• Can persist 5 years post injury

After a brief period of rest during the acute phase (24–48 hours) after injury, patients can be encouraged to become gradually and progressively more active as tolerated (i.e., activity level should not bring on or worsen their symptoms).
Fatigue in mTBI treatment

- Exercise
- Light therapy
- Cognitive Behavioral Therapy (CBT)
- Mindfulness
- Modafinil
- Methylphenidate
  - Caution regarding rebound fatigue
  - Caution re: anxiety
Dizziness/Balance in mTBI

• Most commonly from benign paroxysmal positional vertigo (BPPV)

• DDX:
  • Migraines
  • Medications
  • Other vestibular cause

• Treatment:
  • ENT/multidisciplinary team
  • Vestibular Rehabilitation
  • Epley maneuver on Dix-Hallpike + patients

• **Anxiety is Common**
  • Can be primary reason for dizziness
  • ‘functional overlay’ in magnifying or perpetuating underlying physical symptoms
mTBI and Cognition

- Changes in cerebral metabolic activity and perfusion can occur acutely
  - Attention/Concentration
  - Processing speed
  - Memory
  - Executive Function
  - Other

- Cognitive recovery in 1 week- 6 months
- Cognition should not worsen over time from single mild injury alone
  - 15% + experience persistent cognitive symptoms
mTBI persistent or worsening cognitive symptoms

• Medical reassessment

• Education to reduce misattribution of symptoms to original injury that now may be due to other factors (not just psychiatric factors)

• Graduated reintegration to previous level of function

• Be aware of iatrogenic factors that perpetuate symptoms
  • unnecessary medical workup/referrals
  • controversial or excessive use of treatments

***Physical/cognitive/emotional deconditioning secondary to well-intentioned healthcare professionals prescribing protracted cognitive and physical rest***

Broshek et al.2015
Common Approach To Discussing Psychological Factors that may contribute to Physical Symptoms

Perceived as invalidating and dismissive

Patient distress
- Desperation
- Hypervigilance
- Increased sensitivity

Headache
Dizziness
Fatigue

Anxiety
Depression
Distress

-- Negative outcome when the physician gives the impression that 1 caused 2

Adapted from Gerretsen P
Bidirectional Brain-Body Interaction

1. Headache
   Dizziness
   Fatigue

---

2. Anxiety
   Depression

- Fear of falls
- Fear of reinjury

- Isolation
- Depressed mood
- Anhedonia
- Avoidant behaviors
- Deconditioning
Bidirectional Brain-Body Interaction

- Fear of falls
- Fear of reinjury
- Isolation
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- Deconditioning
Neuropsychiatry & mTBI/concussion

- MAJOR ISSUE!
  - Major Depressive Disorder
  - PTSD
  - Phobias
  - Generalized Anxiety
  - Somatoform disorders
  - Substance Use Disorder

- ‘Vicious Cycle’
  - Bidirectional relation of injury/physical symptoms and psychiatric symptoms
Acute mTBI/concussion Neuropsychiatry

- Irritability, Labile mood, Apathy, Anxiety
  - Transient early acute concussive symptoms vs. primary psychiatric disorder
  - Prompt treatment if symptoms persist or worsen

- Mental status at time of injury important to know
  - Rule out exacerbation of pre-existing psychiatric condition
    - Special Ψ populations in mTBI
      - ADHD
      - Substance Use Disorders
      - Personality Disorders
      - Factitious Disorders/Malingering
Neuropsychiatry & mTBI/concussion

• Neurobiological impact of injury

+ 

• Psychiatric Diagnoses preceding/following
• Psychosocial stressors of injury
  • Inability to work/function/play

• Workplace injury/Legal proceedings
  • BEWARE MALINGERED SYMPTOMS
  • Workplace stressors at time of injury?
mTBI Treatment

- Treatment of medical comorbidities
- Lifestyle & Goal management training
- Cognitive Behavioral Therapy/Mindfulness
- Medications:
  - Start low and go slow
  - One change at a time
- Antidepressants
  - Best evidence Sertraline & Citalopram for anxiety and depression in mTBI
  - Can improve cognition, somatic symptom burden, mood, anxiety, irritability, and improve level of overall function

**Other agents equally useful depending on clinical presentation**
mTBI Treatment

• BE AWARE:
  • Increased sensitivity to cognitive side effects of anticholinergic agents
    • ie. Amitriptyline for headache management
    • Dimenhydrinate for nausea
  • Risk of seizures 1.5x that of general population
    • Special attention to TCA’s, Bupropion, antipsychotics
  • Benzodiazepines
    • Not appropriate as first line therapy or for long term use
    • Risk of dependence, falls, reinjury and cognitive side effects
    • HOWEVER, short term use can be helpful in SOME patients
Post-Concussive Syndrome (PCS)  
“The Miserable Minority”

• Cognitive/Emotional/Physical symptoms similar to those of original injury that persist beyond 3-6 months
  • 15-20% of concussion patients.

• Controversial Cause:
  • Cerebral dysfunction vs. psychiatric vs. other medical cause
  • Generally multifactorial

• By definition symptoms should not worsen from a single concussion/mTBI over time
  • However, many PCS do report worsening or fluctuating symptoms over time

DDX- Persistent Post-Concussion Syndrome

- Major depressive disorder
- Generalized anxiety disorder
- Post-traumatic stress disorder (PTSD)
- Chronic pain syndrome
- Cervical strain/whiplash associated disorder
- Substance abuse or polypharmacy
- Somatic symptom disorder
- Factitious disorder
- Malingering
- Post-traumatic headache
- Post-traumatic dizziness
- Fibromyalgia syndrome (secondary)
- Primary sleep disorder: e.g., obstructive sleep apnea
Post-Concussion Syndrome

• Concussion -> Disrupted Cognition ->
  Psychological Distress/Anxiety -> Anxiety
  Related Cognitive Symptoms -> More Anxiety and Avoidance ->
  Depression/Deconditioning -> Depression Related Cognitive Symptoms ->

• Psychological cognitive overlay may accumulate becoming more disabbling than that from the original physical injury

Broshek et al. 2015
Post-Concussion Syndrome Associated With:

<table>
<thead>
<tr>
<th>INTRINSIC FACTORS</th>
<th>EXTRINSIC FACTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Expectations of Self</td>
<td>External pressure at work/school/sport</td>
</tr>
<tr>
<td>High Harm-Avoidance</td>
<td>Prescribed/protracted rest</td>
</tr>
<tr>
<td>Embitterment/Suspiciousness</td>
<td>Litigation/Insurance</td>
</tr>
<tr>
<td>Depression/Anxiety</td>
<td>?Non-Deliberate vs. Deliberate Exaggeration?</td>
</tr>
<tr>
<td>Trauma history</td>
<td></td>
</tr>
<tr>
<td>Symptom Preoccupation</td>
<td></td>
</tr>
<tr>
<td>Personality traits/disorders:</td>
<td></td>
</tr>
<tr>
<td><em>Histrionic</em></td>
<td></td>
</tr>
<tr>
<td><em>Narcissistic</em></td>
<td></td>
</tr>
<tr>
<td><em>Obsessive Compulsive</em></td>
<td></td>
</tr>
</tbody>
</table>

Broshek et al. 2015; Oldenburg et al. 2018; Iverson & Lange, 2003; Garden et al., 2010, Losoi et al. 2015

Leading the Integration of Physical and Mental Health Care  CONFERENCE 2020
When are symptoms of PCS truly gone?

NOTE: Endorsement of ‘PCS like’ symptoms common in the absence of brain injury in the general population

- 60% of healthy participants meet criteria for PCS in absence of injury

- Severity of original TBI does not necessarily predict PCS symptom burden

Adapted from: Garden & Sullivan, 2010, Wijenberg et al. 2017

<table>
<thead>
<tr>
<th>Post-concussion symptoms</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headaches</td>
<td>81.3</td>
</tr>
<tr>
<td>Dizziness</td>
<td>52.1</td>
</tr>
<tr>
<td>Nausea</td>
<td>53.2</td>
</tr>
<tr>
<td>Fatigue</td>
<td>81.3</td>
</tr>
<tr>
<td>Noise sensitive</td>
<td>34.4</td>
</tr>
<tr>
<td>Irritability</td>
<td>78.1</td>
</tr>
<tr>
<td>Feeling sad</td>
<td>70.1</td>
</tr>
<tr>
<td>Nervous or tense</td>
<td>76.0</td>
</tr>
<tr>
<td>Temper problems</td>
<td>58.3</td>
</tr>
<tr>
<td>Poor concentration</td>
<td>73.4</td>
</tr>
<tr>
<td>Memory problems</td>
<td>56.3</td>
</tr>
<tr>
<td>Difficulty reading</td>
<td>36.5</td>
</tr>
<tr>
<td>Poor sleep</td>
<td>68.8</td>
</tr>
</tbody>
</table>

Note. BC-PSI = British Columbia Post-Concussion Symptom Inventory.
“Good-old-days”
Recall bias in PCS

• “...experience of any negative event, be it accident or illness, head injury or non-head-injury, may be required for one to focus on the past as ‘better’ than one’s current state, for one to think about the ‘good old days’ prior to the negative event”

  Gundstad & Suhr, 2001

• “given that PCS symptoms are relatively non-specific, any negative event may result in report of more current PCS symptoms and fewer PCS symptoms in the past”

  Gundstad & Suhr 2004
RETURN TO ACTIVITY in mTBI history
‘if some rest if good, more is better?’

• Advocacy for bed rest in 1920’s/1930’s after mTBI and many other medical conditions

• 2002 RCT challenges dogma of prescribed rest (de Krujik et al. 2002)

• ‘Rest Until Asymptomatic’ endorsed in Consensus Statements on Concussion into the 2000’s based on expert opinion

• 2016 Canadian Consensus Statement on Concussion in sport recommends gradual re-introduction of activity after a 24-48 hour period of initial rest

• 2017 systematic review confirms a brief 24-48 hour period of cognitive and physical rest followed by gradual increase in activity at subsymptom threshold with submaximal initial exercise beneficial in mTBI (Schneider KJ et al., 2017)

• 2019 study shows little evidence of de-implementation of prescribed prolonged rest and worsened productivity in those advised to rest by a health care practitioner (Silverberg and Otamendi, 2019)
# GRADUATED RETURN TO SCHOOL

<table>
<thead>
<tr>
<th>Stage</th>
<th>Aim</th>
<th>Activity</th>
<th>Goal of each step</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Daily activities at home that do not give the student-athlete symptoms</td>
<td>Typical activities during the day as long as they do not increase symptoms (i.e. reading, texting, screen time). Start at 5-15 minutes at a time and gradually build up.</td>
<td>Gradual return to typical activities</td>
</tr>
<tr>
<td>2</td>
<td>School activities</td>
<td>Homework, reading or other cognitive activities outside of the classroom.</td>
<td>Increase tolerance to cognitive work.</td>
</tr>
<tr>
<td>3</td>
<td>Return to school part-time</td>
<td>Gradual introduction of schoolwork. May need to start with a partial school day or with increased breaks during the day.</td>
<td>Increase academic activities.</td>
</tr>
<tr>
<td>4</td>
<td>Return to school full-time</td>
<td>Gradually progress.</td>
<td>Return to full academic activities and catch up on missed school work.</td>
</tr>
</tbody>
</table>

Canadian Guideline on Concussion in Sport
Adapted from Consensus statement on concussion in sport –5th international conference, Berlin 2016
Return to School (Post-Secondary)

• ASYMPTOMATIC:
  • Return to school as tolerated

• SYMPTOMATIC:
  • 1-2 weeks: no school if debilitated
  • Academic accommodations office for support
  • Medical follow up
  • 2 weeks:
    • Gradual return to school
  • 4 weeks post-injury:
    • If still symptomatic reassess and consider other comorbidities
    • Review accommodations
    • Consider temporary withdrawal from program if negative consequences to grades or participation expected

### Table 3.2. Graduated Return-to-Sport Strategy

<table>
<thead>
<tr>
<th>Stage</th>
<th>Aim</th>
<th>Activity</th>
<th>Goal of each step</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Symptom-limited activity</td>
<td>Daily activity that does not provoke symptoms.</td>
<td>Gradual reintroduction of work/school activities</td>
</tr>
<tr>
<td>2</td>
<td>Light aerobic exercise</td>
<td>Walking or stationary cycling at slow to medium pace. No resistance training.</td>
<td>Increase heart rate</td>
</tr>
<tr>
<td>3</td>
<td>Sport-specific exercise</td>
<td>Running or skating drills. No head impact activities.</td>
<td>Add movement</td>
</tr>
<tr>
<td>4</td>
<td>Non-contact training drills</td>
<td>Harder training drills, e.g., passing drills. May start progressive resistance training.</td>
<td>Exercise, co-ordination and increased thinking</td>
</tr>
<tr>
<td>5</td>
<td>Full-contact practice</td>
<td>Following medical clearance, participate in normal training activities.</td>
<td>Restore confidence and assess functional skills by coaching staff</td>
</tr>
<tr>
<td>6</td>
<td>Return to sport</td>
<td>Normal game play.</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** An initial period of 24–48 hours of both relative physical rest and cognitive rest is recommended before beginning the RTS progression.

There should be at least 24 hours (or longer) for each step of the progression. If any symptoms worsen during exercise, the athlete should go back to the previous step.

Resistance training should be added only in the later stages (stage 3 or 4 at the earliest). If symptoms are persistent (e.g., more than 10–14 days in adults or more than 1 month in children), the athlete should be referred to a healthcare professional who is experienced in the management of concussion.


**The Four Ps can help you gradually increase your activity after a concussion.**

| Prioritize | • Decide what activities are most important to you and what you are able to do, based on how you feel.  
|           | • Make these activities a priority.  
| Plan      | • Plan what activities you will do, when you will do them, how you will do them, and where you will do them.  
|           | • Do activities that require more energy at times in the day when you feel best.  
|           | • Plan rest breaks into your day as you progress toward full return to activity.  
| Pace      | • It may take you longer to complete activities after a concussion.  
|           | • Break up long or difficult tasks so that you are not doing too much at once.  
| Position  | • Environments that are noisy, are busy, or require a lot of physical effort, like too much standing, will use more energy.  
|           | • Be thoughtful about *where* you do an activity. Start with quiet places that have few distractions.  

SECOND IMPACT SYNDROME (SIS)

- Concussed brain cells vulnerable to reinjury within a close temporal window
  - Second ‘non-lethal’ injury in a short time can cause these cells to die
- 2 ‘non-lethal’ injuries in close proximity can cause catastrophic injury
  - Malignant brain swelling
  - Increased intracranial pressure
  - Erratic cerebral perfusion
- POTENTIALLY FATAL

Signoretti S et al., 2011
CHRONIC TRAUMATIC ENCEPHALOPATHY (CTE)

- Proposed to be a progressive neurodegenerative/neurocognitive disorder as a late effect of repetitive head trauma
  - Typically pro-athletes/military personnel
  - 8-10 years after repetitive brain injury
  - *Dementia Pugilistica* (Punch Drunk Syndrome) -> CTE
  - There remains controversy

- Symptoms may include personality change, depression, anxiety, impulsivity, aggression, memory difficulty, parkinsonism and suicidality
  - Many other reasons these symptoms may occur before or after injury

Randolph C, 2018; Zuckerman et al., 2018
CTE:

NEUROPATHOLOGICAL diagnosis postmortem (Tauopathy)

CANNOT DIAGNOSE CTE IN LIVING PATIENTS:

- Lack of clear clinical profile
  - Many possible explanations for reported symptoms
  - No definitive biomarkers
  - Neuropathological findings not consistent in symptomatic versus not

- Iatrogenic Fear and Anxiety
  - May be seen as ‘Death Sentence’
  - Irreversible psychological harm possible in absence of definitive standards to diagnose and prognosticate

Randolph C, 2018; Zuckerman et al., 2018
Key Messages

• Concussion/mTBI is common

• Concussion is a CLINICAL diagnosis and imaging is **not** required in the absence of red flags

• Signs and symptoms are typically short-lived, but may persist in some cases
  
  • Bidirectional relationship of somatic/psychological symptoms
  
  • Consider other medical and psychiatric causes

• Encourage gentle activity and gradual return to function instead of prescribed protracted rest

• Caution re: Secondary Impact Syndrome

• CTE is controversial and is a post-mortem diagnosis
Questions?
References

• GUIDELINE FOR CONCUSSION/MILD TRAUMATIC BRAIN INJURY & PERSISTENT SYMPTOMS. Ontario Neutrotrauma Foundation. May 2018.  
  www.onf.org

• CANADIAN GUIDELINE ON CONCUSSION IN SPORT | PARACHUTE  
  www.parachutecanada.org