

PHYSICAL THERAPY MANAGEMENT  
OF  
PEDIATRIC PATIENTS POST-CONCUSSION

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Capstone Project, Spring 2018

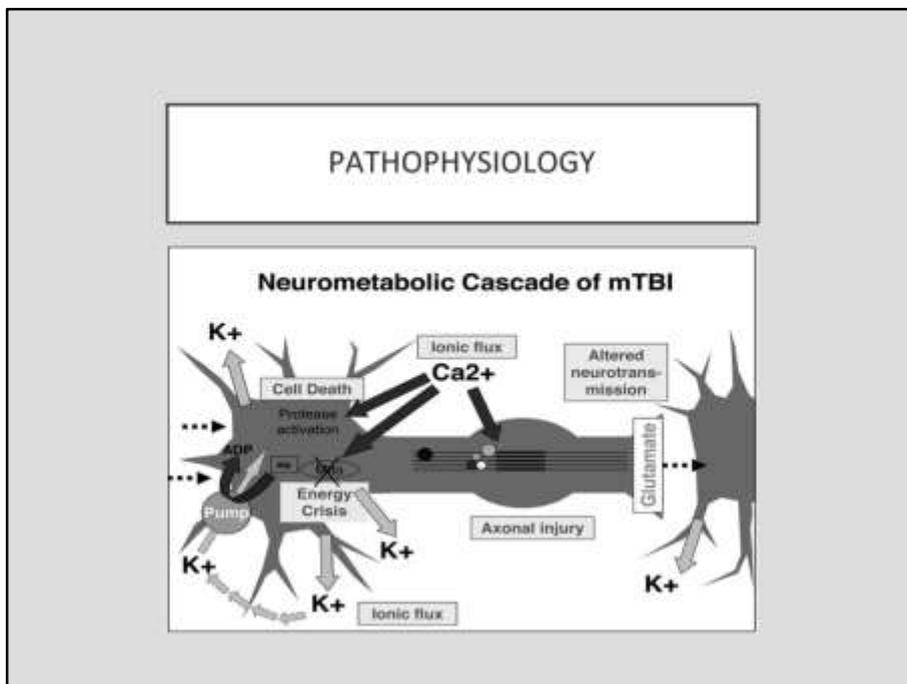
## OBJECTIVES

- Identify common etiology and pathology of concussion in pediatric populations
- Define post-concussion syndrome
- Discuss possible clinical presentations related to concussion and post-concussion syndrome
- Discuss physical therapists' role in post-concussion management
- Outline examples of assessment and intervention for post-concussion management

We will start with a brief review of general concussion concepts and then move into a conversation regarding post-concussion syndrome, or “PCS”.

We'll talk about how PCS presents clinically in children and adolescents. We will then explore PT management of these patients, including a discussion of a typical evaluation, a variety of potentially useful assessment tools, and evidence-based intervention strategies.

While this presentation does focus on the pediatric population, many of the concepts we cover are applicable to adult patients with PCS so you should be able to gain some clinical insight from this lecture regardless of the patient populations you're interested in working with.

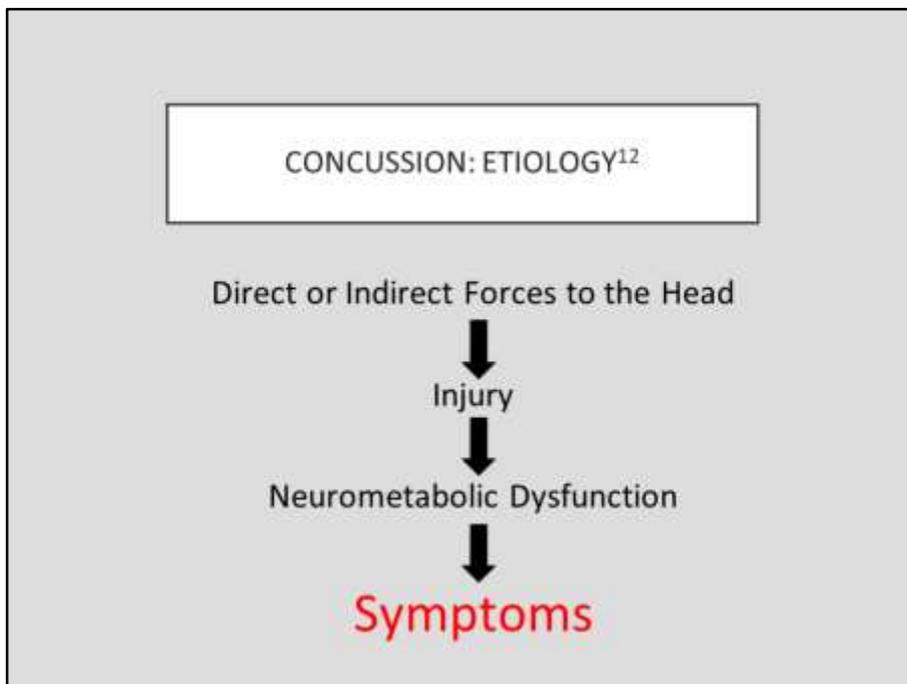


Don't feel overwhelmed by this image! We'll walk through it together! You will have learned about the neurometabolic cascade involved in TBI during previous neuro courses, so I won't go into too much detail here. Broadly, Injury → Release of  $K^+$  → Influx of  $Ca^{++}$  → Metabolic Dysfunction (or "Energy Crisis") & Altered Release of Neurotransmitters<sup>1</sup>

"The pathophysiological response to mild traumatic brain injury includes a complex neurometabolic cascade of events resulting in a neurologic energy deficit."<sup>4</sup> Here you can see a simplified version of this neurometabolic cascade.

Metabolic dysfunction and unorganized release of neurotransmitters within the brain results in neural energy deficits and communication dysfunctions between neurons, which in turn result in many of the cognitive and functional symptoms we associate with concussion.<sup>1</sup>

image 2: <http://www.neurosurgery-blog.com/wp-content/uploads/2014/10/The-New-Neurometabolic-Cascade-of-Concussion.jpg>



**Concussion: What is it?**

“A concussion... is a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces secondary to **direct or indirect forces to the head.**”<sup>1</sup>

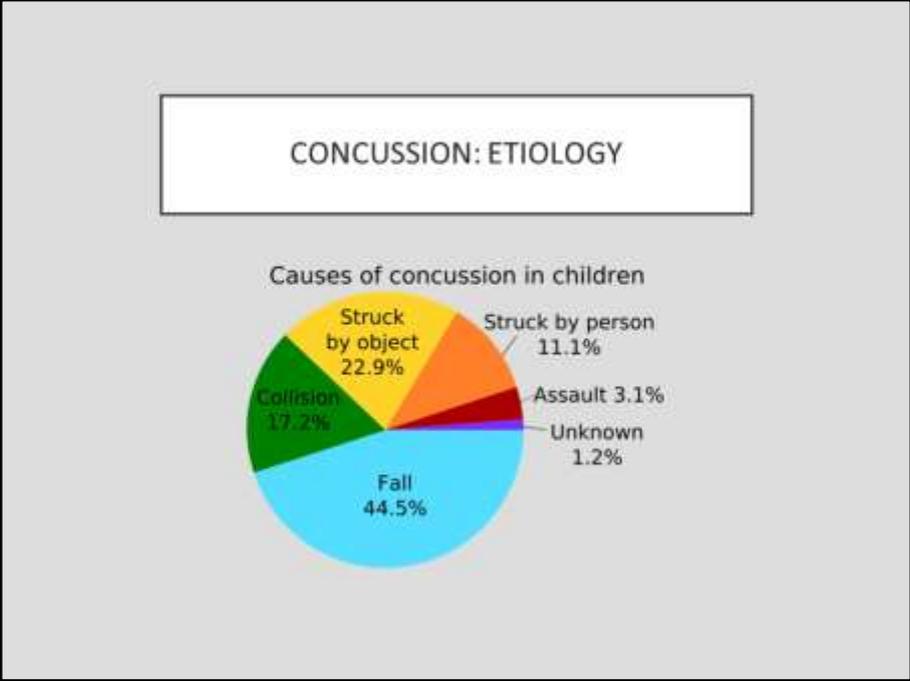
In general, the same biomechanical/physiological mechanisms are at play in concussions as in more severe TBIs, meaning that “acceleration/deceleration, translational, rotational, and/or angular forces” acting on the brain result in neural injury.<sup>1</sup>

A hallmark of concussion is that resulting brain dysfunction is seen as most commonly arising from pathophysiological neurometabolic dysfunction as opposed to structural damage seen in more severe forms of TBI, meaning that imaging techniques such as CT or MRI are often unable to pick up the neural injury resulting from concussion.<sup>21</sup>

Individuals may or may not experience a loss of consciousness during as a result of concussive injury and brain injury can certainly occur without LOC.<sup>1</sup> In fact, less than 10% of concussions involve a loss of consciousness (LOC).<sup>1</sup> Some sources support

memory of pre and post-injury events as a better indicator of concussion severity than LOC.<sup>1</sup>

It's worth mentioning that the terms "concussion" and "mTBI" are often used interchangeably in the literature. One author notes "most would agree that concussion lies on the 'milder' end of the mTBI spectrum."<sup>3</sup> While this may be true, concussion is a serious diagnosis, both in that it puts individuals at increased risk of more serious neural damage, via 2<sup>nd</sup> impact syndrome, and that it can present with long lasting, and often underrecognized symptoms.<sup>4</sup>



Falls and impact by or against an object (such as being hit in the head by a baseball or hitting your head against a steering wheel) are some of the most common causes of concussion in all age groups.<sup>5</sup> Specific to the pediatric population- the CDC reports that younger children are more likely to experience concussion as a result of a fall, while adolescents are more likely to experience a concussion due to being hit by or against an object.<sup>5</sup> This discrepancy may be due to higher rates of participation in sports within the 15-24 year old age range.<sup>5</sup>

Other Causes to be aware of include: MVC and assault.<sup>5</sup>

The data for this graph is drawn from from a 2007 study of concussion in Canadian students- while you shouldn't fixate on the percentages I think it does a good job of touching on the variety of causes that can lead to concussion in this population.

image 1: [https://commons.wikimedia.org/wiki/File:Causes\\_of\\_concussion.svg](https://commons.wikimedia.org/wiki/File:Causes_of_concussion.svg)

CONCUSSION:  
SPECIAL CONSIDERATIONS IN PEDIATRICS

- Higher risk
- Differences in anatomy
- Risk of repeated injury

Increased awareness regarding concussion means parents, coaches, and school staff are more likely to seek medical help for children who may have experienced a concussion, meaning more children and adolescents are getting medical assistance for post-concussion symptoms.<sup>5,11</sup> So PTs are more and more likely to come in contact with these patients.

Statistically, children (especially those who are very young and those who are adolescents) are at higher risk for concussion than many other age groups- children aged 0-4 and 14-18 years old make up two of the three age groups in which concussion is most likely to occur (with older adults aged 65 and above making up the third)<sup>12</sup> 65% of SRCs occur in children between 5 and 18 years of age.<sup>1</sup>

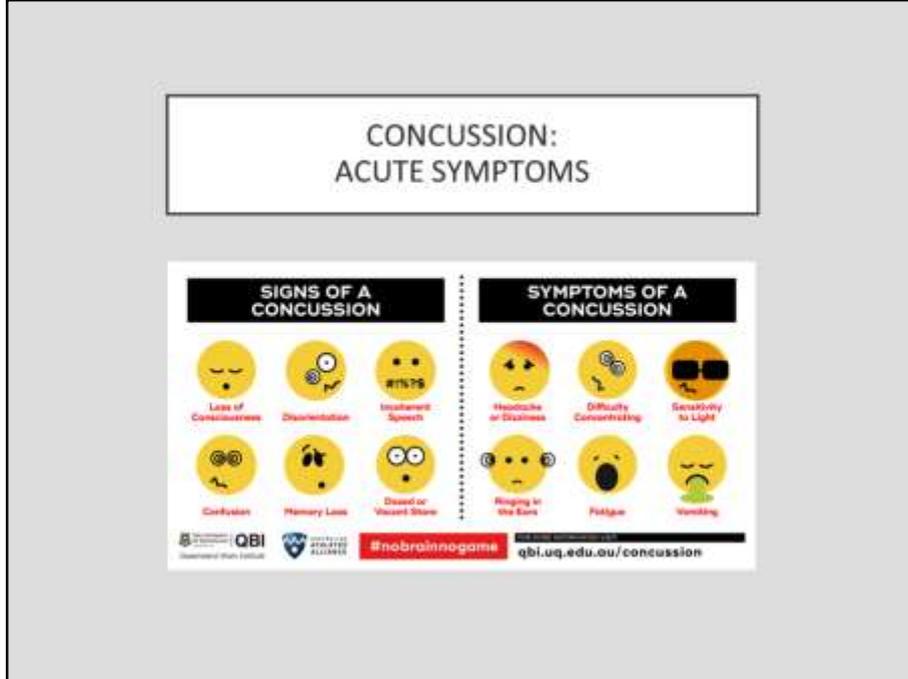
Age-dependent anatomical differences, such as decreased neuronal myelination and underdeveloped cervical and shoulder musculature “ result in decreased ability to absorb mechanical energy throughout (children’s) bodies.”<sup>1</sup>

Acute neurometabolic changes may persist in children for up to 4 weeks post-concussion, during which time neural structures may be more vulnerable to

repeated injury.<sup>2</sup> Neuroplasticity and axonal function may be impaired in the acute and sub-acute period.<sup>2</sup>

Literature on concussion will often site a recovery period of 10-14 days, but research indicates that children and adolescents may take up to four weeks to recover from concussion.<sup>2,3,13</sup> The CDC reports that up to 10% of children will experience post-concussion symptoms which last years beyond the initial concussive injury.<sup>1</sup>

**image 3:** [http://www.roccem.com/wp-content/uploads/2015/03/concussion\\_10.gif](http://www.roccem.com/wp-content/uploads/2015/03/concussion_10.gif)



In the days immediately after a concussive injury an individual may experience some combination of these symptoms. Many of these symptoms arise from the afore mentioned neurometabolic cascade- but mechanical damage, incurred during whatever event initially caused the concussion, to musculoskeletal structures, especially in the c-spine, or to the vestibular system can also contribute to acute symptoms.<sup>2,7</sup>

During this acute period many authors argue that patients are at greater risk of reinjury, or “second impact syndrome”, due in part to the “energy deficit” created during the post-injury neurometabolic cascade, which plays into the treatment concept that “rest is best”, which we will discuss shortly.<sup>4</sup>

image 4: [https://concussion.qbi.uq.edu.au/files/1623/Concussion-signs-and-symptoms\\_QBI-research.png](https://concussion.qbi.uq.edu.au/files/1623/Concussion-signs-and-symptoms_QBI-research.png)

## CONCUSSION: ACUTE SYMPTOMS

**Table 1. Common Symptoms of mTBI\***

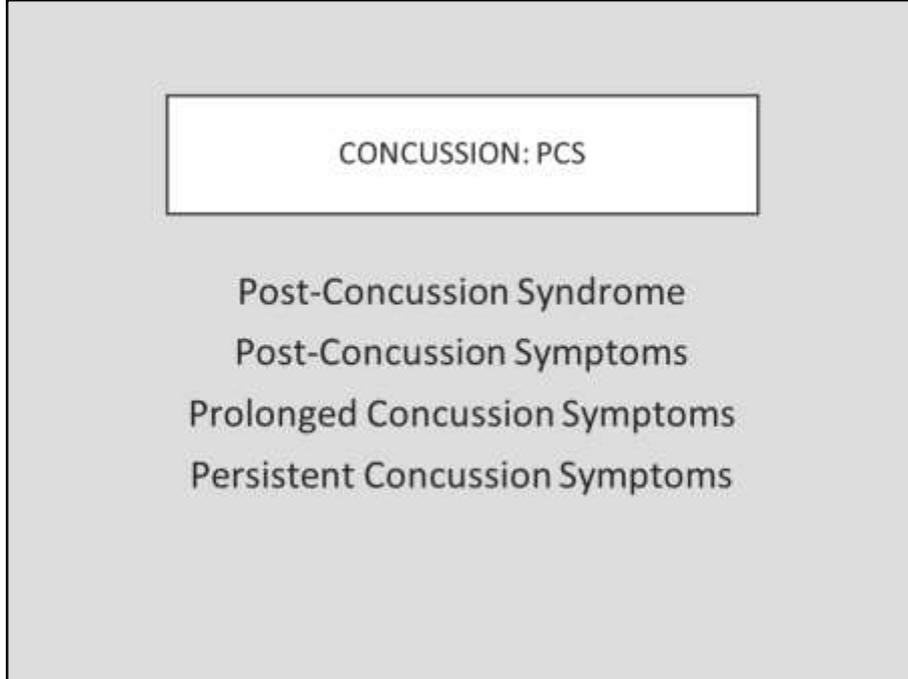
Physical	Behavioral/Emotional	Cognitive
Headache Nausea Vomiting Blurred or double vision Seeing stars or lights Balance problems Dizziness Sensitivity to light or noise Tinnitus	Drowsiness Fatigue/lethargy Irritability Depression Anxiety Sleeping more than usual Difficulty falling asleep	Feeling "slowed down" Feeling "in a fog" or "dazed" Difficulty concentrating Difficulty remembering

This table comes from the Ontario Neurotrauma Foundation's Guidelines for Concussion/Mild Traumatic Brain Injury and Persistent Symptoms and goes a bit more in depth as to different symptom domains. Feel free to pause and read it over.

CONCUSSION:  
THE SLOW TO RECOVER PATIENT

“10–15% of individuals with mTBI will continue to experience persisting symptoms even after 1 year.”<sup>3</sup>

While the majority of individuals with concussion will recover relatively quickly (1-2 weeks for most adults, ~ a month for most children) prolonged post-concussion symptoms are reported in a significant percentage of patients each year.<sup>3,8</sup>



Here we see a number of terms under the umbrella of the “PCS” term which are used somewhat interchangeably in the literature to describe concussion-acquired symptoms of abnormal duration.

POST-CONCUSSION SYNDROME: 2018 ICD-10-  
CM DIAGNOSIS CODE F07.81

"The organic and psychogenic disturbances observed after closed head injuries (head injuries, closed). Post-concussion syndrome includes subjective physical complaints (i.e. Headache, dizziness), cognitive, emotional, and behavioral changes. These disturbances can be chronic, permanent, or late emerging."<sup>9</sup>

Just as reference, here we have the most recent ICD-10 definition of "post-concussion syndrome".

Note that this definition does not include a specific timeframe post-injury. The important thing is to recognize that concussion can have long lasting effects on patients and that these symptoms are not "normal".<sup>6</sup>

### PCS: SYMPTOMS<sup>3,6,7</sup>

- Headache
- Balance Disorders
- Persistent Dizziness
- Persistent Fatigue
- Cervical Pain
- Persistent Sleep Disturbance
- Persistent Vision Disorders
- Persistent Cognitive Difficulties
- Disorders of Mood/Affect

While individual patients will each have their own unique presentations, here we can see what are considered the most common symptoms associated with PCS. Highlighted in blue are those symptoms which a PT might expect to address.

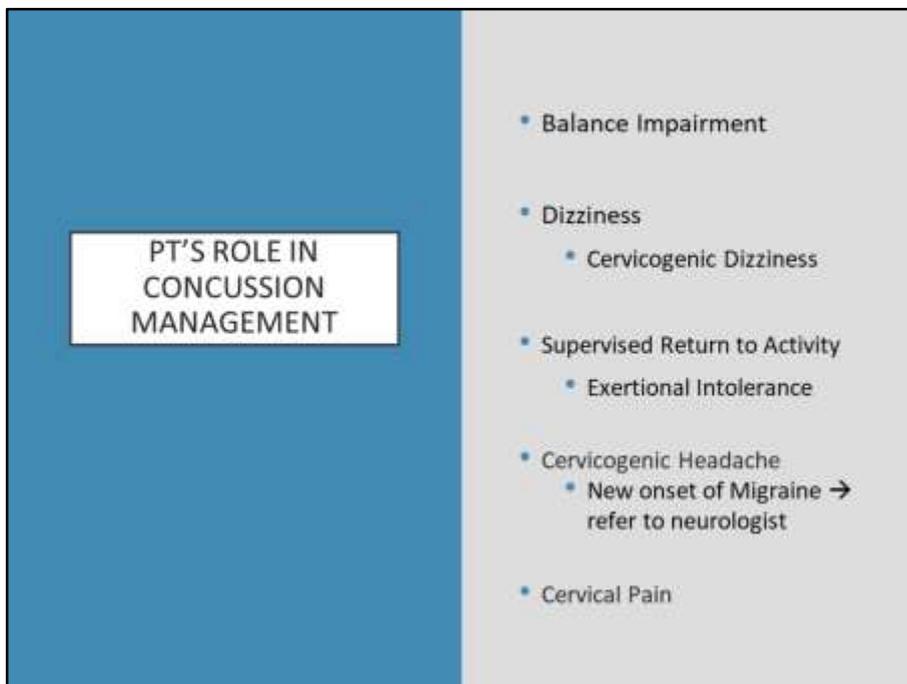
### PCS: GENERAL RED FLAGS<sup>10</sup>

- Deteriorating conscious state
- Increasing confusion or irritability
- Severe or increasing headache
- Repeated vomiting
- Unusual behavior change
- Seizure or convulsion
- Double vision
- Weakness or tingling / burning in arms or legs
- Person complains of neck pain → [screen c-spine](#)

### Red Flags<sup>10</sup>

By the time a patient makes it to PT for treatment post-concussion they most likely will have already been screened by other medical professionals. Even so it's important for us to keep our eyes out for major swings in presentation. These "red flags" come from Parachute Canada, which has a number of helpful resources for healthcare professionals working with patients with concussion. I'll provide you with a link to their website at the end of this presentation.

Obviously clinical judgement is going to play into how we screen for red flags. For example, one reason a patient might be referred to PT post-concussion is for cervical pain. While cervical pain might be indicative of something outside our practice scope, such as fracture, it may also indicate something within our scope, such as soft tissue damage, so a cervical spine screening would be an appropriate first step, versus immediate emergency medical referral. In contrast, a patient who experiences sudden convulsions requires immediate emergency medical attention.



So what is our role in managing patients, and in particular children and adolescents, who are experiencing post-concussion symptoms?

Here are some of the major areas you might expect to address with these patients. You might come in contact with these patients in a formal “concussion clinic” such as the one hosted at the CRC, in a general outpatient setting, in a home-health setting, or in the school system.

While physical therapists working in the hospital may see patients in the immediate acute period post-concussion, the majority of PT interactions with these patients will come later in the patient’s recovery process.

## PT EVALUATION

"The assessment and management of an individual with persistent mTBI-related symptoms should be directed toward the **specific symptoms, regardless of their aetiology or elapsed time from injury.**"<sup>3</sup>



Pt complaints still need to match injury specific impairments.

One of the hallmarks of post-concussion symptomology is that it is highly individual in nature. Not every patient who experiences a concussion will experience post-concussion symptoms that interfere with their function. And of those who do, not all will experience the same symptoms. So it is important to assess what symptoms a patient is experiencing and tailor their plan of care appropriately.<sup>3,6,7,15</sup> We also want to keep in mind that many of the symptoms associated with PCS may be unrelated to concussion. For example, if a patient has a history of headache, and continues to experience headache following their concussion you might hesitate to link their headaches to the concussion. Patient complaints should match with injury specific impairments to fall under the post-concussion scope.

image 5: <http://nittygriddy.com/wp-content/uploads/2011/02/thinking-cap.gif>

SUBJECTIVE:  
PAST MEDICAL HISTORY<sup>3</sup>

- Concussions
- Migraine
- Hyperactivity
- Depression
- Sleep disturbance
- Balance impairment
- Most recent visit to optometrist

Certain past medical history factors, such as those listed here, may increase a patient's likelihood of experiencing prolonged post-concussion symptoms, though research in this area is still evolving.<sup>3</sup>

## SUBJECTIVE

- PLOF
- MOI
- LOC
- Other care providers
- Medication review
- Return to school/work?

The subjective component of evaluation should also touch on a pt's prior level of function, as this will help establish therapy goals. Mechanism of injury can inform what should be included in the objective evaluation section (for example whether a patient may be experiencing soft tissue injury to their neck).

These patient's may be followed by a number of other providers, including : vision therapy, neuropsychologist, headache specialist, along with their PCP.

Pts may be taking OTC meds, such as NSAIDs, to address PCS symptoms like headache or cervical pain. We'll touch on this again when we address return-to-activity protocols, but pt's will need to be free of symptoms without meds, prior to full return to sport, so its important to know at baseline if they are using any meds. When asking about return to work/school you should include questions addressing their tolerance for physical activities, as well as activities such as reading or computer use that require both mental and visual focus.

SUBJECTIVE  
SYMPTOM SEVERITY  
ASSESSMENTS

Concussion Specific  
Measures

- Post-concussion Syndrome Symptom Scale (PCSSS)<sup>28</sup>
- Rivermead Post Concussion Questionnaire (RPQ)<sup>28-32</sup>
- British Columbia Post-concussion Symptom Inventory (BC-PSI)<sup>28</sup>
- Post-concussion Syndrome Checklist (PCSC)<sup>28</sup>

These assessments can be helpful in both identifying what a pt's main subjective complaints are and tracking them over time. These can help clinicians hone in on less obvious PCS symptomology such as depression or anxiety, which we definitely want to have on our radar as these are commonly associated with PCS, especially when recovery is prolonged.

PT's at the CRC utilizes the PCSS and the DHI in their concussion clinic, but there are a variety of assessment tools that are appropriate for use in this patient group.

These measures are patient report for the most part, so depending on the age of your patient may require parental input.

You only need to pick one of these!



Here are a few more pt report measures that might come in handy.

## PT EVALUATION: OBJECTIVE

- Pain
- Posture
- Strength
- Gait
- ROM (esp. cervical)
- Coordination
- Vestibular/Balance Screen
- Cervical Spine Screen
- Activity Tolerance Assessment

As always, you're going to let the subjective component of your exam guide the objective component. As discussed before, mechanisms of injury which result in concussion often overlap with those which might cause cervical or vestibular injury, so we want to check those areas out- especially if the subjective evaluation is guiding us in that direction.<sup>7</sup>

## VESTIBULAR INVOLVEMENT

### POTENTIAL DIAGNOSES

- Central Vestibular Deficit
- BPPV
- Other forms of UPVD

### PRESENTATION

- Issues of gaze stability (VOR)
- Vertigo
- Dizziness
- Postural stability deficits
- Balance impairment

Vestibular diagnoses which have been linked to balance impairments, nausea, dizziness, and vertigo seen in PCS include central vestibular deficit, benign paroxysmal positional vertigo (BPPV) and other forms of unilateral peripheral vestibular dysfunction (UPVD) such as unilateral hypofunction brought on by mechanical damage to CN VIII or to the structure of the inner ear.<sup>3,15,18</sup> These conditions may result in dysfunction of the vestibulo–ocular reflex (VOR) (i.e. issues with gaze stability), a sense of vertigo or “dizziness,” and/or issues with postural stability, all of which can impact a patient’s balance.<sup>3,6</sup>

## VESTIBULAR/BALANCE SCREEN

- Oculomotor screen
- VOR Testing
- Screening for BPPV
- Postural Control/Balance

There are a number of components when it comes to assessing a patient with dizziness, vertigo, and/or balance complaints related to concussion. In the next few slides I provide you with tools that you might choose to include in your assessment of a patient. As most of these tools have been discussed in depth in prior neuro courses I do not go into specifics of each technique. Please feel free to pause the presentation and review individual tools at your own pace if you feel inspired to do so!

VESTIBULAR INVOLVEMENT;  
OCULOMOTOR SCREEN<sup>19-22</sup>

- Cranial Nerves II,III,IV,VI, AND VIII
- Nystagmus
- Stabisumus/Ocular Alignment
- Checking for general symmetry
- Visual tracking/smooth pursuit
- Saccades
- Visual Convergence

Here I've outlined some components of a routine oculomotor screen. I would recommend looking into VOMs, the Vestibular/Ocular-motor Screening tool which is recommended for use in concussion.

Info on VOMS is provided on the following slide.

## VOMS: Vestibular/Ocular-Motor Screening for Concussion

- Brief clinical screen to assess for vestibular/ocular-motor involvement following concussion.
- <https://www.physiotherapyalberta.ca/files/vamstool.pdf>
- Mucha A, Collins MW, Elbin RJ, et al. A Brief Vestibular/Ocular Motor Screening (VOMS) assessment to evaluate concussions: preliminary findings. *Am J Sports Med* 2014;42(10):2479-2486. doi:10.1177/0363546514543775.

VESTIBULAR INVOLVEMENT: VOR TESTING<sup>19-22</sup>

- Dynamic Visual Acuity Testing
- Head Thrust Technique
- NeuroCom® inVision system

[http://www.natus.com/index.cfm?page=products\\_1&crid=273](http://www.natus.com/index.cfm?page=products_1&crid=273)

image 15: [http://neurosigns.org/images/thumb/c/c5/HIT\\_from\\_DeJong\\_cropped.jpg/300px-HIT\\_from\\_DeJong\\_cropped.jpg](http://neurosigns.org/images/thumb/c/c5/HIT_from_DeJong_cropped.jpg/300px-HIT_from_DeJong_cropped.jpg)

The neuroCom inVision system is worth looking into, especially as we'll see this used in some of the case study videos associated with this lecture. This system can be used as an assessment and treatment tool.



benign paroxysmal positional vertigo  
 Dix-Hallpike for posterior canal  
 Roll Test: screens for horizontal canal

**image 13:** <https://aliem.com/wp-content/uploads/2011/08/Hallpike.jpg>

**image 14:**

[https://www.researchgate.net/profile/Ji\\_Kim24/publication/258959242/figure/fig6/AS:203105040900102@1425435423365/Supine-roll-test-in-geotropic-benign-paroxysmal-positional-vertigo-involving-the-right.png](https://www.researchgate.net/profile/Ji_Kim24/publication/258959242/figure/fig6/AS:203105040900102@1425435423365/Supine-roll-test-in-geotropic-benign-paroxysmal-positional-vertigo-involving-the-right.png)

POSTURAL CONTROL/BALANCE<sup>19,22-25</sup>

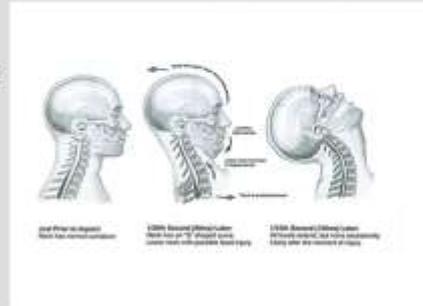
- Functional Gait Assessment (FGA)
- Balance Error Scoring System (BESS)
- Clinical Test of Sensory Integration on Balance (CTSIB)/ Modified CTSIB
- Sensory Organization Test (SOT)
- Berg Balance Scale (BBS)
- Dynamic Gait Index (DGI)
- High-Level Mobility Assessment Tool (HiMAT)
- Community Balance and Mobility Scale (CBMS)

While there are many options when picking an assessment tool for postural control and balance, I've highlighted these last two- the HiMAT and CBMS- because we want to really capture our patients abilities and some patients with PCS will be functioning beyond what a more low level assessment tool like the BESS would capture, but still won't be at their pre-concussion baseline.

Both the HiMAT and CBMS have been normed in TBI populations, and the HiMAT especially is often utilized in studies of adolescents and young adults.

## CERVICAL SPINE: POTENTIAL DIAGNOSIS

- Whiplash
- Cervicogenic Headache
- Cervical Pain
- Cervicogenic Dizziness



Patients with cervical involvement are likely to have fairly obvious patient presentations- i.e. their neck will hurt and/or they'll report onset of cervicogenic-type headaches since their concussion. It's worth noting that, as mentioned earlier, children may be at greater risk of soft tissue damage to the neck during concussive injury because the still developing nature of their cervical and shoulder musculature.

image 12: [http://www.tspineandjoint.com/s/cc\\_images/teaserbox\\_888562427.jpg?t=1419191885](http://www.tspineandjoint.com/s/cc_images/teaserbox_888562427.jpg?t=1419191885)

## CERVICAL SPINE: ASSESSMENT<sup>7</sup>

- **Clear the C-spine**
- Cervical Joint-Position Error Test
- Smooth-Pursuit Neck-Torsion Test
- Head-Neck Differentiation Test
- Cervical Flexion Rotation Test

Start this component of the eval by clearing the cervical spine. It's probably been done before, but these patients have often experience traumatic impacts so it's better to be safe than sorry. Here we also have a number of tools recommended by Cheever et al for distinguishing between post-concussion symptoms arising from central, vestibular, or cervical origins.<sup>7</sup>

## ACTIVITY TOLERANCE: IS REST BEST?

"Humans do not respond well to removal from their social and physical environments, and sustained rest adversely affects the physiology of concussion and can lead to physical deconditioning and reactive depression."<sup>14</sup>

"In concussed pediatric patients, mood dysregulation and adjustment disorders can be further worsened by extreme rest that includes social isolation, missed school, and child–parent conflicts over excessive regulation of behavior."<sup>4</sup>

Now we'll move into a discussion of managing patient's with exertional intolerance and general concepts of return-to-activity.

These two quotes speak to reasons we might be clinically skeptical of a prescription of complete cognitive and physical rest for patients post-concussion.

## ACTIVITY TOLERANCE: IS REST BEST?

- 1-2 days post-concussion: Rest is Best
- >1-2 days post-concussion: Symptom-Limited Activity is Best

Rest → Return-to-Learn → Return-to-Sport

Prescription of complete cognitive and physical rest, beyond the first few days following concussion, has been challenged in recent years by research which links prolonged rest to risk of physical and cognitive deconditioning and depression.<sup>4</sup> Additionally, a growing body of evidence from animal studies links participation in exercise (after an initial period of rest) to decreased inflammation and increased “molecular markers of neuroplasticity” both of which may facilitate neurorehabilitation.<sup>4</sup>

A recommendation of 1 to 2 days of rest prior to starting a rehabilitation program comes from the 2015 clinical practice guideline by Marshall et al.<sup>3</sup>

Current literature supports a recovery progression which begins with 24-48 hrs of initial rest, followed by return to social and school activities prior to sport.<sup>3</sup> These same concepts can be applied to adults by simply replacing “return-to-school” with “return-to-work” or even “return to usual activity.”

ACTIVITY TOLERANCE ASSESSMENT: BUFFALO  
CONCUSSION TREADMILL TEST<sup>14</sup>



The Buffalo Concussion Treadmill Test is used to identify the submaximal, symptom-limited exercise threshold in individuals after concussion. “The Buffalo Concussion Treadmill Test is the only functional test known to safely and reliably reveal exercise intolerance in humans with PCS.”<sup>14</sup> This is done by monitoring HR during exercise and noting the point at which symptom exacerbation occurs.

This data is then used to determine the subthreshold HR to be prescribed for exercise. When the pt can exercise at their max exertion without causing symptom exacerbation they are considered “physiologically recovered.”<sup>14</sup>

**image 6:** [http://www.buffalo.edu/ubreporter/archive/2012\\_09\\_13/images/ConcussionClinic.jpg](http://www.buffalo.edu/ubreporter/archive/2012_09_13/images/ConcussionClinic.jpg)

## PT INTERVENTIONS



Clinical interventions will be highly specific to each patient. As the body of research exploring the role of PT in post-concussion management deepens so will our toolbox of interventions strategies. Since this an area of research which is constantly evolving I would highly encourage students to do some exploring into where research is currently in regards to specific interventions!

INTERVENTIONS:  
VESTIBULAR/BALANCE<sup>3</sup>

- **Balance Exercises:** Standing Static → Dynamic → Sport Specific
- Cervical Proprioceptive Training
- VOR/Gaze Stability Training: eye-head coordination exercises
- Dual Task Activities
- Ambulation exercises
- Epley and Semont maneuvers (for BPPV)

While the efficacy of vestibular rehabilitation for patients with certain forms of dizziness, vertigo, and balance impairments is well supported in the literature, there is often a lack of specificity as to what intervention strategies were utilized during studies.<sup>25,39</sup> This is likely due in part to the “no-one-size-fits-all” nature of concussive vestibular impairment. Instead of treating all post-concussion patients who present with vestibular complaints the same, its important to thoroughly assess each patient and treat individual symptoms.

With that as a grain of salt- here are some of the intervention strategies we might utilize with this patient population.

In a 2013 review of exercise prescription patterns in patients treated with vestibular rehab post-concussion, Alsalaheen et al identified these as the most commonly utilized interventions.<sup>39</sup>

## INTERVENTIONS: AEROBIC ACTIVITY



Current research supports the inclusion of supervised, submaximal/symptom-limited aerobic exercise in management of post-concussion symptoms and has found this to be an effective way to increase patients' tolerance for activity after concussion.<sup>14</sup>

Utilizing the results of a patient's Buffalo Concussion Treadmill Test, PT's can implement a program of sub-symptom exercise.<sup>14</sup>

Working off of this concept, a number of studies have combined symptom-limited aerobic activity with coordination and visualization exercises to positive effect.<sup>40</sup>

For a good article on this check out:

*Leddy J, Hinds A, Sirica D, Willer B. The role of controlled exercise in concussion management. PM R 2016;8(3 Suppl):S91-S100. doi:10.1016/j.pmrj.2015.10.017.*

**image 7:** [http://96bda424cfcc34d9dd1a-0a7f10f87519dba22d2dbc6233a731e5.r41.cf2.rackcdn.com/level10fitness1/Screen\\_Shot\\_2015-05-09\\_at\\_8\\_52\\_07\\_PM.png](http://96bda424cfcc34d9dd1a-0a7f10f87519dba22d2dbc6233a731e5.r41.cf2.rackcdn.com/level10fitness1/Screen_Shot_2015-05-09_at_8_52_07_PM.png)

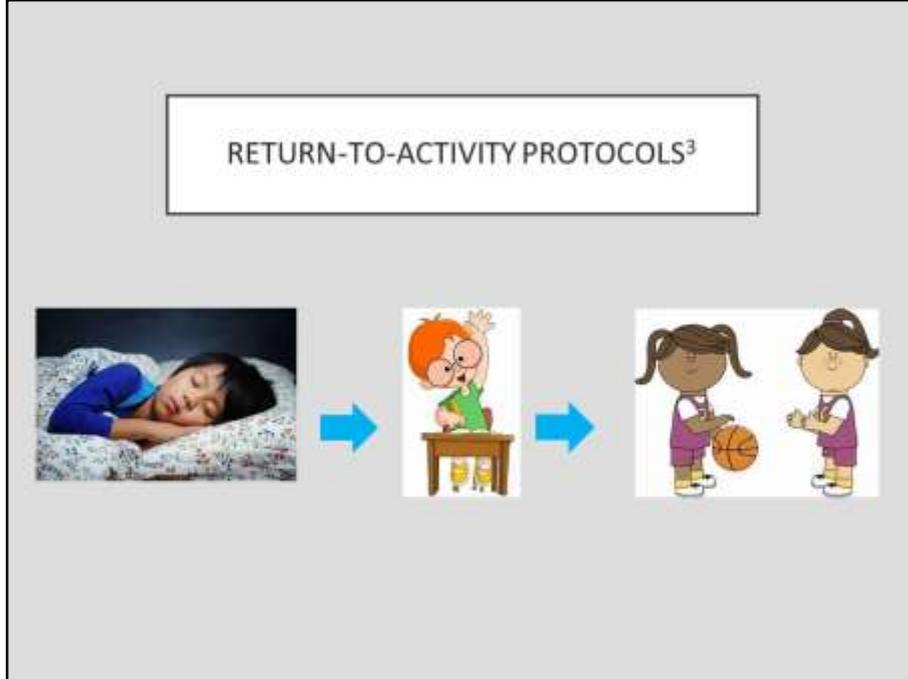
## ADDITIONAL INTERVENTIONS

- Manual Techniques
- Postural Re-Education
- Patient Education



Manual interventions and postural re-education may be beneficial for patient's presenting with whiplash, cervical pain, and cervicogenic headache. Patients and their families will benefit from ongoing education regarding prognosis, symptom management, and plan of care.

**image 8:** [https://image.freepik.com/free-vector/correct-and-incorrect-postures-for-activities\\_23-2147633332.jpg](https://image.freepik.com/free-vector/correct-and-incorrect-postures-for-activities_23-2147633332.jpg)



While much of the literature related to post-concussion management in pediatric patients is based on research centered on student athletes, it is important to remember two things- firstly not all concussions arise from a sports-related trauma, and secondly the importance of returning to sport should not overshadow the importance of returning to school and social activities.<sup>3</sup> In fact, in a recent clinical practice guideline for concussion Marshall et al specifically states that patients should return first to school and social activities before returning to sport.<sup>3</sup>

**image 9:** <https://salempf.files.wordpress.com/2014/07/asian-kid-asleep.jpg>

**image 10:** <http://freedesignfile.com/upload/2013/09/School-cartoons-1.jpg>

**image 11:** <https://i.pinimg.com/originals/ee/9c/b5/ee9cb554f9082e85ff178096fce15228.png>

## RETURN-TO-LEARN

Table 2: Graduated Return-to-School Strategy<sup>11</sup>

Stage	Aim	Activity	Goal of each step
1	Daily activities at home that do not give the child symptoms	Typical activities of the child during the day as long as they do not increase symptoms (eg, reading, texting, screen time). Start with 5–15 min at a time and gradually build up	Gradual return to typical activities
2	School activities	Homework, reading or other cognitive activities outside of the classroom	Increase tolerance to cognitive work
3	Return to school part-time	Gradual introduction of schoolwork. May need to start with a partial school day or with increased breaks during the day	Increase academic activities
4	Return to school full-time	Gradually progress school activities until a full day can be tolerated	Return to full academic activities and catch up on missed work

Here we have a return-to-school protocol outlined by McCorry et al in their recent consensus statement on concussion in sport.<sup>13</sup> It's good to be aware that this protocol exists, but don't get hung up on the particulars. This might be an area where you'd communicate with a school PT if you're seeing a child in an outpatient setting.

## RETURN-TO-SPORT

Table 1. Graduated Return-to-Sport (RTS) Strategy.<sup>13</sup>

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

Here we have we have a return-to-sport protocol as outlined by McCroy et al.<sup>13</sup> Note that step 1 = participation in a return-to-learn protocol. Remember this protocol comes *after* an earlier return-to-learn protocol (highlighted here in yellow.)

In regards to medication- its important to note that even over the counter medications like NSAIDs may mask PCS symptoms such as headache which would signal the patient is not safe to return to impact activities yet.<sup>13 3</sup>

“Continue to proceed to the next level if asymptomatic at the current level. Generally, each step should take 24 hours so that an athlete would take 1 week to proceed through the full rehabilitation protocol once he or she is asymptomatic at rest and with provocative exercise. If any post-concussion symptoms occur while in the stepwise program, then the patient should drop back to the previous asymptomatic level and try to progress again after a further 24-hour period of rest has passed.”<sup>3</sup>

Athletes should not return to sport if they are taking meds for PCS symptoms.<sup>3 13</sup>

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- **Image 1:** <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3838389/>
- **Image 2:** <http://www.neurosurgery-blog.com/wp-content/uploads/2014/10/The-New-Neurometabolic-Cascade-of-Concussion.jpg>
- **Image 3:** <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3838389/>
- **Image 4:** <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3838389/>
- **Image 5:** <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3838389/>
- **Image 6:** <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3838389/>
- **Image 7:** <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3838389/>

## RESOURCES

- **Image 8:** <https://www.gettyimages.com/detail/stock-photo/young-woman-reading-book-against-whiteboard-background-1017147452-1017147452.jpg>
- **Image 9:** <https://www.gettyimages.com/detail/stock-photo/young-woman-reading-book-against-whiteboard-background-1017147452-1017147452.jpg>
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- **Image 12:** <https://www.gettyimages.com/detail/stock-photo/young-woman-reading-book-against-whiteboard-background-1017147452-1017147452.jpg>
- **Image 13:** <https://www.gettyimages.com/detail/stock-photo/young-woman-reading-book-against-whiteboard-background-1017147452-1017147452.jpg>
- **Image 14:** <https://www.gettyimages.com/detail/stock-photo/young-woman-reading-book-against-whiteboard-background-1017147452-1017147452.jpg>
- **Image 15:** <https://www.gettyimages.com/detail/stock-photo/young-woman-reading-book-against-whiteboard-background-1017147452-1017147452.jpg>

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