



Children's Health Ireland

Departments of Emergency Medicine, Surgery and Neurology

### CONCUSSION – ACUTE AND SUBACUTE MANAGEMENT

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#### Concussion Algorithm

#### Mild - Moderate TBI Algorithm

#### Aim

Define acute and subacute management of concussion (mild traumatic brain injury) and post concussive syndrome (PCS)

To provide criteria for categorizing head injuries.

To define criteria for safe discharge home, and the advice on discharge.

To educate people on concussion or 'mild traumatic brain injury' and post concussive syndrome

#### Head Injury Severity Scale (HISS)<sup>1</sup>

<b>Minimal Head Injury</b>	=	<b>GCS 15, no LOC, no amnesia, asymptomatic</b>	
<b>Mild TBI</b>	=	<b>GCS 14-15, amnesia or LOC &lt;5mins, or impaired alertness</b>	<u>AVPU</u>
<b>Moderate TBI</b>	=	<b>GCS 9-13, LOC &gt;5mins or focal deficit</b>	<u>AVPU</u>
<b>Severe TBI</b>	=	<b>GCS 5-8</b>	<u>AVPU</u>
<b>Critical TBI</b>	=	<b>GCS 3-4</b>	<u>AVPU</u>

#### Concussion Severity Scale (Cantu<sup>2</sup>)

Factors	Mild (Grade 1)	Moderate (grade 2)	Severe (grade 3)
<b>Loss of Consciousness</b>	<b>None</b>	<b>&lt;1 min</b>	<b>&gt;1min</b>
<b>Amnesia (anterograde or retrograde)</b>	<b>&lt; 30mins</b>	<b>&gt; 30mins</b>	<b>&gt;24hrs</b>
<b>Post Concussive Signs and Symptoms other than amnesia</b>	<b>&lt;24hrs</b>	<b>&gt;24hrs</b>	<b>&gt;7 days</b>

**Minimal Head Injury** = A Head Injury which does not affect the functioning of the brain, and therefore from which there are no symptoms.

**Mild TBI/Concussion** = 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. It results in the rapid onset of short-lived impairment of neurological function. Acute clinical signs and symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies. It may or may not result in loss of consciousness. Signs and symptoms may evolve over minutes, hours or days and resolution may be spontaneous or prolonged.

**Post Concussive Syndrome** = Symptoms in children beyond 4 weeks<sup>3</sup>. Symptoms include: headache, dizziness, fatigue, irritability, impaired memory and concentration, insomnia, and lowered tolerance for noise and light.

**Second Impact Syndrome** = Poorly understood, thought to be that brain vasculature loses its ability to autoregulate after the first traumatic brain injury. The disruption of autoregulation leads to cerebral oedema and engorgement because the brain cannot compensate by decreasing blood flow. It is exceedingly rare.

**Chronic Traumatic Encephalopathy** = Autopsy diagnosis of microscopic evidence of primary and secondary proteinopathies- Tau, amyloid and TDP proteinopathy, in patients known to have suffered from repeated traumatic brain injuries. Clinically, CTE is associated with behavioral changes, executive dysfunction, memory deficits, and cognitive impairments that begin insidiously and most often progress slowly over decades.

There is currently no evidence that one mTBI results in CTE<sup>4</sup>.

**Post Traumatic Headache from mTBI– occurs within 7 days OF ONE OF THE FOLLOWING:**

Injury to the head OR regaining consciousness following injury to the head OR following discontinuation of medication that impairs the ability to sense or report headache following injury to the head<sup>5</sup>

Acute – Resolves within 3 months of injury

Persistent – more than 3 months<sup>5</sup>

**Target Patient Population**

This evidence summary applies to children aged 0-16 with mild traumatic brain injury mTBI (concussion) and Post Concussive Syndrome presenting to the Emergency Department and Outpatient setting. It does not address the initial and emergency management of head injury

**Target Users**

Health-care professionals engaged in the care of children in the Emergency Department/ Outpatient setting. A separate guideline addresses management of [minor / moderate head injuries](#) and [trivial / minimal head injuries](#) and the ongoing management of severe TBI GCS<8 in the ICU setting

**Assessment**

*Introduction* 6000-7000 children present to Dublin ED’s annually with head injury. It is important to diagnose mild traumatic brain injury when it presents to prevent further brain dysfunction and unnecessary concern. Post concussive symptoms can persist beyond 3 months. It can grossly impair a child’s ability to function physically, cognitively and psychologically. Prompt recognition and treatment lessens the impact.

*History*

History of presenting complaint	<b>Time of and mechanism of injury</b> <b>Area of head hit and speed of impact</b>
Differentiating factors in mild v moderate	<b>GCS / AVPU</b> at time of event, since, and now <b>Loss of Consciousness</b> and its duration <b>Amnesia</b> pre or post event, specifically ask to recall events and duration <b>Seizure</b>
History typical of concussion (Always consider need for CT brain separately as per head injury guideline)	Headache (early post traumatic) Disorientation/ Confusion Reported pallor/ ‘dazed’ look Nausea/ Vomiting including <b>number of discreet episodes</b> and timing Ataxia/ Dizziness Visual symptoms/ Blurring/ Light insensitivity Fatigue
Evolution of symptoms	<b>Clinical course improving/deteriorating?</b>
Special considerations in history	Consider seizure or arrhythmia as precedent to injury Circumstances- child protection concerns? Previous head injuries/ concussions Medical conditions / Medications/ pain relief Past hx of <b>bleeding disorder / warfarin tx</b> Other injuries

*Factors in BOLD help assess whether imaging is necessary*

### Assess for symptoms of concussion:

*It is helpful to ask the CHILD, or as the parent to ask a shy child, 'Tell me what you were doing when this happened? How did you get up? Who came to help you first?' This assesses for amnesia.*

### Manage Expectations:

#### Assess Risk Factors for Post Concussive Syndrome

1. Previous concussion
2. learning disability, dyslexia
3. ADHD
4. Autism
5. migraine history
6. car sickness
7. anxiety
8. family stressors

### Neuropsychological Testing: SCAT assessment

- *These tests provide a baseline. Improvement in symptom scoring on repeat testing can help reassure patients. Give a copy of the assessment to parents on discharge or forward to GP*  
*SCAT tests assess symptoms, cognitive testing and balance.*  
*SCAT child age 5-12years: <https://bjsm.bmj.com/content/bjsports/early/.../bjsports-2017-097492childscat5.full.pdf>*  
*SCAT aged 13+: <https://bjsm.bmj.com/content/bjsports/early/2017/04/26/bjsports-2017-097506SCAT5.full.pdf>*  
*Post Concussion Symptom Inventory can assess symptoms alone before and after and can be assessed at intervals: <https://www.olchc.ie/Files-Uploaded/Clinical-guidelines-companion-documents/Postconcussion-Symptom-Scale-form.pdf>*  
*IMPACT online may be used to assess improvement at intervals*

### Full Neurological Exam and also:

- Check for saccadic eye movements when challenged to look L to R to L, rapidly, as they will fatigue and it will become more obvious.
- Check for a lengthened convergence distance- children should not see double when accommodating on an object until within 6 cm towards the nose\*  
Saccadic eye movements,<sup>6</sup> poor accommodation, headache, vestibulo-ocular symptoms at presentation<sup>7</sup> risk ongoing symptoms.  
Video of assessment at Children's Hospital Philadelphia: <https://www.youtube.com/watch?v=Uy8V5MGX8Ag>

RISK SCORING SYSTEM FOR EXPECTED PERSISTENT POST CONCUSSIVE SYMPTOMS AT 28 DAYS	
Age	Score
5-7	0
8-12	1
13<18	2*
Sex	
Male	0
Female	2*
Prior Concussion and symptom duration	
None, or Symptoms <1wk	0
Prior Concussion, Symptoms >1wks	1
Physician diagnosed migraine history	
No	0
Yes	1
Balance error score	
0-3	0
4+ or unable to take test	1
Headache	
No	0
Yes	1
Sensitivity to Noise	
No	0
Yes	1
Fatigue	
No	0
Yes	2

\*RR Score >2

Score	Estimated Risk %
Low Risk:	
0	4.1
1	5.8
2	8.3
3	11.8
Medium Risk:	
4	16.4
5	22.3
6	29.7
7	38.2
8	47.6
High Risk:	
9	57.1
10	66.1
11	74.1
12	80.8

Taken from: Zemek R, Barrowman N, Freedman SB, et al; Pediatric Emergency Research Canada (PERC) Concussion Team. Clinical risk score for persistent post-concussion symptoms among children with acute concussion in the ED. *JAMA*. 2016;315(10): 1014-1025. doi:10.1001/jama.2016.1203

**Investigations:**

*Imaging:* See [Minor / Moderate Head Injury presenting to the ED](#)

*Biomarkers:* There is no role for biomarkers in concussion at beyond the research setting

*Screening tools:* [California Providence Post Concussion Symptom Scale form](#)

**Management:**

**Concussion Algorithm**

**Mild - Moderate TBI Algorithm**

- **Reassurance**
- **Avoidance of precipitating factors** Aim during observation in the ED to keep the room or area dark. Allow the child to rest their eyes, avoid ambulation, avoid screen time or reading, avoid texting, as these may precipitate vomiting (like travel sickness).
- **Parent information leaflet**

24-48hrs	No Exercise No TV / ipad / screentime No schoolwork No late nights
For 2weeks	Brain Rest if still symptoms e.g. from homework/modified school days <u>Resumption of screen-time will mirror that of school activities.</u> Gentle physical activity that doesn't risk head injury as tolerated Increase physical activity gradually 2 days Light aerobic 2 days Moderate exercise – running/drills 2 days Complex drills, resistance exercise, thereafter normal training If symptoms return, drop back a level to that which was previously tolerated
At 3weeks (3 weekends missed)	Can play matches again if has been well in previous two weeks, otherwise delay return.

- **Cognitive Rest** (from both academic activities AND technology) 2 days rest then gradual resumption of activities that do not precipitate symptoms. Watching screens and reading requires saccadic eye movement. Schools should modify learning in response to symptoms. Children with dizziness/visual symptoms may find reading difficult.
- **Physical Rest** 2 days rest then gradual resumption of activities that do not precipitate symptoms. Beyond 4 weeks physical activity below the level that precipitates symptoms is shown to improve symptoms. 5 days full rest reported more symptoms than 2 days absolute rest<sup>8</sup>.

**\*Note** The advice regarding exercise is changing and recent study report better symptoms with return to exercise at 7 days<sup>9</sup>. This does not however explore the risk of a 2<sup>nd</sup> impact and so the rules for risk of repeat head trauma should be observed.

- Avoid sport/activity that risk 2<sup>nd</sup> impact x23 days minimum
- **Pain relief:** Acute headaches: medication (paracetamol, ibuprofen) as early as possible, as per dosing instructions for 3-5days. Sub-acutely limited to 3 times/wk to avoid **overuse headache**. Rest, Sleep, Hydration, Regular meals, avoid caffeine.

Optimize treatment of other conditions associated with head injury- migraine, tension headaches and muscular strain- Muscular neck pain should be seen by physiotherapy. Cautious use of benzodiazepines for muscle spasm.

Consider obtaining imaging of children with severe or worsening headache, acutely or sub-acutely.

- **Sleep Management**

May have problems with circadian rhythm, onset of sleep, daytime sleepiness.

Sleep hygiene: Dark room, no technology, wind down prior to sleep, cut out caffeine, strict routine e.g. same bedtime.

Sleep Requirements (National Sleep Foundation):

Newborns (0-3 months): Sleep range 14-17 hours

Infants (4-11 months): Sleep range 12-15 hours

Toddlers (1-2 years): Sleep range 11-14 hours

Preschoolers (3-5): Sleep range 10-13 hours

School age children (6-13): Sleep range 9-11 hours

Teenagers (14-17): Sleep range 8-10 hours

- **Manage Expectations**

20-30% will not be recovered fully at one month. Typically symptoms can persist for 7-10 days. Children at high risk of Post-Concussion Syndrome (pre morbid history and/or high scoring on scoring scale) should have follow up arranged. Adequate acute treatment of symptoms can prevent chronic symptoms<sup>10</sup>  
Emphasise compliance

- **Other**

Regular meals/snacks and hydration

Physiotherapy – for cervicogenic symptoms of headache and also for vestibulo-ocular rehabilitation

## Special Considerations

### Persistent symptoms beyond 4wks- not appropriate for ED management

Referral to general paediatrics OPD is appropriate for symptoms persisting beyond 1-3 months.

**Investigations:** *Post Concussive Symptom Inventory* is useful in assessing for improvement in symptoms at intervals

### Care is individualised to symptoms.

There is evidence to support symptom limited exercise, targeted vestibular-ocular therapy for ataxia/dizziness (via occupational therapy), cognitive behavioural therapy<sup>3</sup>( via psychology services)

**Balance:** Physiotherapy.

### Mood:

CAMHs is warranted for psychological and MDT support and to aid return to education where school absenteeism/depression prominent.

### Persisting cognitive symptoms:

Cognitive defects may be primary or secondary, i.e. directly related to neurotransmission or secondary to poor sleep, ongoing headaches, fatigue, low energy, frustration – neuropsychological evaluation (via psychology services) helps determine and aid targeted treatment.

### Headache:

Screen for depression/ anxiety, substance misuse, disordered sleep, relation to menstrual cycle. Consider starting triptans for migraines: NEVER in first 72hrs. NOT IF any neurological features e.g. weakness/ paraesthesia – specialist referral. ONLY 9 days per month should they be taken.

NO opioids or barbiturates.

Chronic headaches may be multifactorial, check neck muscle tension/tenderness for referred pain, exclude other causes e.g. analgesia overuse.

Define type:

	Duration	Quality	Location	Associations
Migraine	2-72hrs	Throbbing	Unilateral / bilateral frontotemporal	Nausea/ vomiting Photophobia Phonophobia Aura
Tension	30mins- hrs Variable frequency	Pressing tightening	Bilateral	NO Nausea/ Vomiting Not worse with physical activity
Occipital neuralgia	Continuous	Steady	Unilateral, Occipital nerve	Paraesthesia Dysesthesia Tenderness Nerve block relieves it
Cervico-genic	Variable	Dull, Steady Aching	Unilateral or Bilateral Occipital but can be anterior	Neck sore/stiff Trigger points Worse with posture/ Movement. Muscle tenderness Nerve blockage can relieve it
Medication overuse	Continuous Daily	Steady or Migraine like Or tension like	Bilateral	May be like original headache Associated with other cognitive features. Features: hrs after taking offending meds Often there on wakening There >15days/mo Use of simple analgesia >15days/mo Use of migraine meds/opioids >10days/mo Will get worse for 2 wks after stopping

- Consider rare diagnoses vascular dissection, TIA/ Stroke, cerebral vein thrombosis, subacute subdural haematoma, cervical spine injury
- Specific signs of concern with ongoing headache include: abnormal neurological exam, worsening headache, nocturnal awakenings, headaches induced by Valsalva.
- C-spine MRI may be considered in cervicogenic headaches.

### **When is repeat imaging appropriate?**

MRI should be performed in patients with clinical or neurological deterioration.

**Biomarkers** There is no role for blood biomarkers outside the research setting

### **Discharge Requirements**

- [Concussion advice sheet for parents](#)
- Normal conscious state

### **Appendix 1**

Video of assessment at Children's Hospital Philadelphia:

<https://www.youtube.com/watch?v=Uy8V5MGX8Ag>

### **Appendix 2**

Post Concussive Symptom Inventory Scoring:

[California Providence Post Concussion Symptom Scale form](#)

### **Companion Documents:**

#### [References](#)

[Concussion Algorithm](#)

[Mild - Moderate TBI Algorithm](#)

[Concussion Information Leaflet](#)

[California Providence Post Concussion Symptom Scale form](#)

[Concussion Assessment Video from Children's Hospital Philadelphia](#)