Pediatric Concussions
latest approach to management

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Pediatric Emergency Medicine

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Overview

- Concussion
  - When to worry
  - Brain rest
  - When to refer
- Post-traumatic headache
  - Occipital nerve blocks
Case study

- 14 year old soccer injury
- Stunned x 5 minutes
- Headache persists x 24 hours
Concussion

Consensus statement on concussion in sports, 4th international conference, Zurich, 2012

McCrory et al. 2013
Brain injury ... a subset of mild traumatic brain injury (mTBI)
Spectrum of TBI

Mild
Moderate
Severe
Concussion

- Brain injury ... a subset of mild traumatic brain injury
- Complex pathophysiological process with a functional disturbance
Functional MRI

fMRI mTBI Cognitive Paradigm

Control  Low PCS  Moderate PCS
Pathophysiology

10 days
Concussion

- Brain injury … a subset of mild traumatic brain injury
- Complex pathophysiological process … functional disturbance
- Induced by biomechanical forces
  - Direct blow to head or elsewhere with “impulsive” force to head
Coup

Whiplash coup
Concussion

- Rapid onset of short-lived impairment in neurologic function
- … albeit may evolve over hours
- ± loss of consciousness
Concussion

- Recovery usually within 2-3 weeks
- Pediatric often longer ...
  - 55% symptomatic at 1 month
  - 14% symptomatic at 3 months
  - 2% symptomatic at 12 months
Management Goals

- Diagnosis
- Minimize likelihood for post-concussion syndrome and/or 2nd injuries
- Target therapies to improve speed and magnitude of recovery
Acute injury

- Basic trauma assessment
  - ABCDE
  - Life threatening injuries
    - Focal neurologic findings
    - Glasgow coma scale < 14
On the field

- Loss of consciousness (LOC)
- Balance/motor incoordination
- Confusion
- Amnesia
- Blank/vacant look
Maddock’s questions

“I am going to ask you a few questions”
- Where are we at now?
- Is it before or after lunch?
- What did you have last class?
- What is your teacher’s name?
Return to play = NO
Acute injury

- Basic trauma assessment
  - ABCDE → life threatening injuries

- Serial observation
  - Appearance of symptoms might be delayed hours → evolving injury acutely
In the emergency department (ED)
In the ED

- Goal #1: red flags for injury
  - Is there an intra-cranial bleed?
  - Is there a cervical spine injury?
Risk versus benefit
CT and radiation

Risk ~1/1000 to 1/5000
When to image?

- CATCH
- PECARN

r/o intra-cranial bleed
Red flags

- GCS < 15
- Worsening headache
- Worsening vomiting
- Irritable
- Severe mechanisms
- Suspected skull fracture (basal, depressed, open)
Tincture of time

- Evolution of symptoms and signs since injury
Figure 1: Algorithm for the management of the paediatric patient ≥2 years of age with minor head trauma. CT Computed tomography; ED Emergency department.
When to image?

- **CATCH**
- **PECARN**
  - r/o intra-cranial bleed

- **NEXUS**
  - r/o cervical spine injury
In the ED

- **Goal #1: Red flags for injury**
  - Is there an intra-cranial bleed?
  - Is there a cervical spine injury?

- **Goal #2: Diagnosis**
  - Does this patient have a concussion?
Acute Concussion

- **Symptoms**: ex. headache, nausea
- **Signs**: ex. loss of consciousness, pallor
- **Behaviors**: ex. irritable, emotionally labile
- **Cognitive**: ex. “foggy”/slow, confusion, amnesia
- **Sleep**: ex. fatigue, insomnia
Diagnostic criteria

Any one or more:

- Initial obvious signs (LOC, convulsion, gait unsteadiness)
- Observer reports “off” (cognitive, behavior, emotion)
- Patient reports symptoms on concussion
- Abnormal neurocognitive and/or balance exam

(McCrory et al. 2013)
Assessment includes:

- Mental status
- Cognitive functioning
- Neurologic exam
- Gait
- Balance
Standardized concussion assessment tool (SCAT3 & Child SCAT3)
Neurologic exam

- Level of consciousness
- Pupil reactivity
- Extra-ocular movements
- Gross motor
- Coordination
- Gait
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(McCrory et al. 2013)
Cognitive assessment

- Orientation
- Immediate memory
- Concentration
- Delayed memory
Balance
Balance error scoring system (BESS)
Diagnosis = Concussion

...now what
Brain Rest
Headache Management (1st weeks)

- Rest
- Ibuprofen x 3 days
  - Limit 3 days / week → rebound
- Severe pain
  - Maxeran IV, 0.5 mg/kg
    (max 10 mg/dose)
  - May repeat x 3
Graded Return

- School
- Sports
Back to case

- Assessment
- Reassurance
- Counseling
- Written documentation
- MD notes for school/sports
A mild traumatic brain injury (MTBI), also referred to as a concussion, is a disturbance in brain function that can be caused by a blow to the head, jaw, face, neck or body.

The following information is geared towards children and teenagers.

**Common causes of an MTBI**
- falls from a height at home (beds, changing tables, high chairs, stairs)
- falls at a playground or at school
- sports or recreational activities
- motor vehicle collisions (passenger, driver, pedestrian or cyclist)
- violent acts

**Common signs and symptoms of an MTBI**
- headache
- nausea and vomiting
- dizziness
- loss of consciousness
- feeling dazed and confused
- memory loss
- poor balance or coordination
- drowsiness
- irritability
- agitation
- fatigue

Your child or teenager has been examined and can return home at this time. However, certain symptoms may appear within 72 hours following the injury. If any of the following develop, seek medical attention at an emergency department immediately:
- Increasing headache, especially if localized
- Persistent vomiting
- One pupil becoming larger than the other
- Behavioural changes (persistent irritability in younger children; increased agitation in teens)
- Excessive drowsiness (difficult to arouse)
- Difficulty seeing, hearing, speaking or walking
- Seizure
- Confusion or disorientation (does not recognize people or places)
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What to expect following an MTBI?

Signs and symptoms following an MTBI usually last 1 – 2 weeks but may occasionally last longer. Frequently reported are: headache, dizziness, nausea, sleep disturbances, fatigue, irritability and restlessness, sensitivity to light, sound and motion, difficulty with memory, concentration, attention span, judgment or balance.

It is very important to allow a child or teenager to rest both physically and cognitively until he/she is fully symptom-free. This reduces the chance of developing persistent symptoms.

Restrictions and recommendations for school and other activities during the recovery period:

- Inform day-care, school personnel and coaches of the MTBI and the restrictions
- Return to school gradually; half days for the first few days and increase to full days as tolerated
- No academic exams, tests, quizzes, projects or oral presentations during the first two weeks
- No gym, playground, sports or other strenuous activities
- Do not attend sport practices as they may interfere with the resting period
- Do not attend music classes or lessons, drama classes or dance classes
- Supervised leisure swimming is permitted; no diving or jumping
- Adequate rest and breaks are encouraged
- Limit time spent on video games and computers, texting, watching television and playing musical instruments as these activities may provoke headaches
- Allow students to bring a bottle of water to the class; dehydration may provoke headaches

Additional recommendations for teenagers:

- Avoid going to parties and movies, excessive noise and lights may provoke headaches
- Absolutely no drugs or alcohol
- Avoid driving until symptoms have resolved

Complete resolution from MTBI related symptoms is essential before returning to activities. This reduces the chance of having another MTBI with increased and prolonged symptoms.

If symptoms have not resolved in approximately 2 weeks following the MTBI, further consultation by the Neurotrauma/MTBI Program is recommended.

Please call 514-412-4400 x 23310.

The child or teenager must be completely symptom free at rest for one week prior to resuming physical activity. At that point, gradual return to physical activity over a few days is recommended.
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Return to learn

Attendance Restrictions: No school for 2 days then progress to:

- Half-days to full days as tolerated
- Allow for late arrival or early departure

Testing: No testing for a minimum of two weeks

Students who have sustained a concussion can experience an increase in memory and attention problems. Highly demanding activities such as testing can significantly increase these symptoms and cause headaches and fatigue subsequently making testing more difficult. While the student is symptomatic, it is recommended that he/she have:

Workload reduction:

A concussed student may require more time to complete assignments due to an increase in memory problems and decreased speed of processing. It is therefore recommended to reduce the cognitive load, which may include reducing homework during the first week, and allocating additional time for projects and assignments.

When the student is symptom-free for one consecutive week, a gradual approach to testing is important:

- Additional time to complete tests
- Allow testing across multiple sessions
- Open book/take home tests when possible
- Reformat from free response to multiple choice
- Testing in a quiet environment
- Reduced length of tests
- Allow 1-2 days between tests

Emergency Department MD Signature:


H:\Public\Protocols and forms\Academic Recommendations Rev. Sept 2013
Return to learn
Return to sports

Returning to physical activity and sports following an MTBI

If your child or teenager plays organized sports, have him/her follow these progressive steps before returning to play.

There should be approximately 24 hours in between each step. If any symptoms return at any time during this action plan, stop working out. Rest until you are symptom-free for 24 hours, then return to the previous step. If symptoms do not resolve or get worse, seek medical attention.

**STEP 1 Light general conditioning exercises**
- NO CONTACT.
- Begin with a warm up (stretching/flexibility) for 5-10 minutes.
- Start a cardio workout of 15-20 minutes which can include: stationary bicycle, treadmill, fast-paced walking, light jog, rowing or swimming.

**STEP 2 General conditioning and sport specific skill work done individually**
- NO CONTACT.
- Begin with a warm up (stretching/flexibility) for 5-10 minutes.
- Increase intensity and duration of cardio workout to 20-30 minutes.
- Begin sport specific skill work in the workout, but no spins, dives or jumps.

**STEP 3 General conditioning, skill work done individually and with a team-mate**
- NO CONTACT.
- Increase duration of sessions to 60 minutes.
- Begin resistance training.
- Continue practicing sport specific individual skills.
- May begin general shooting, blocking or passing drills with a partner.
- Start beginner level spins, dives and jumps.

**STEP 4 General conditioning, skill work and team drills**
- NO CONTACT, NO SCRIMMAGES.
- Resume pre-injury duration of practice and team drills.
- Increase resistance training and skill work as required.
- Gradually increase skill level of spins, dives and jumps.

**STEP 5 Full practice with body contact**
- CONTACT, SCRIMMAGES.
- Participate in full practice to get yourself back in the lineup. If completed with no symptoms, discuss with the coach about getting back in the game.
- Coaches must make sure that the athlete has regained his/her pre-injury skill level and is confident in his/her ability to return to activity.

**STEP 6 Return to competition**

**PREVENTION TIPS**
- Wear appropriate standardized protective equipment. Make sure it fits.
- Wearing a helmet decreases the severity of brain injuries.
- Participate in activities that are appropriate for your age and skill level.
- Physical preparation, proper conditioning and skill training is fundamental.
- Fall play which includes teamwork, sportsmanship, respecting the rules and zero tolerance to violence is essential.
- Never play through an injury. Seek medical attention early on and follow the recommendations.

**TRAUMA**

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- May begin general shooting, kicking or passing drills with a partner.
- Start beginner level spins, dives and jumps.

Seek medical attention, test and follow the recommendations.

TRUAMA

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**STEP 6** Return to competition!
- Full practice.
- Sport-specific drills.
- Physical fitness and sport psychology.
- Participate in full practice and games.
- Begin with light contact and increase gradually.
- Never play through an injury.
- Seek medical attention early on and follow the recommendations.

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REPRENDRE LE SOCCER APRÈS UNE COMMOTION CÉRÉBRALE

Si vous avez subi une commotion cérébrale, il est recommandé de suivre cette stratégie de retour au jeu avant de reprendre votre chandail d'équipe.

Vous devez respecter toute la période de repos recommandée et suivre les restrictions imposées. Souvenez-vous que vous ne devez jamais repasser à vos activités que si vous n'avez pas de symptômes au repos depuis au moins une semaine. Lorsque vous êtes prêts à revenir au jeu, suivez ces étapes en y allant progressivement.

Il doit s'écouler au moins 24 heures entre chaque étape. Si vous éprouvez de nouveau des symptômes durant cette remise en forme, cessez toute activité. Reposez-vous jusqu'à ce que vous n'ayez plus de symptômes durant 24 heures, puis repassez à l'étape précédente. Si les symptômes ne se résolvent pas ou s'aggravent, vous devez consulter un médecin sans tarder.

★ ÉTAPE 1 : Légers exercices de conditionnement
- Commencer par 5 à 10 minutes d'exercices d'échauffement (étirements/flexibilité);
- Enchaîner avec 15 à 30 minutes d'échauffement pouvant comporter : vélo stationnaire, tapis roulant, marche rapide, course légère, aviron ou natation.

★ ÉTAPE 2 : Conditionnement et habiletés spécifiques au sport ; individuellement
- Commencer par 5 à 10 minutes d'exercices d'échauffement (étirements/flexibilité);
- Augmenter l'intensité et la durée de l'échauffement (20 à 30 minutes);
- Commencer les exercices d'habileté spécifiques au soccer : course, dribbles statiques et dynamiques avec les côtes, et coups de pied.

★ ÉTAPE 3 : Conditionnement et habiletés spécifiques au sport ; individuellement et avec un coéquipier
- AUCUN CONTACT;
- Augmenter la durée de la séance d'échauffement à 60 minutes. Commencer l'entraînement en résistance;
- Commencer les exercices avec un partenaire : dribbles, passes et lancers sur le gardien;
- Commencer à revoir les stratégies de jeu en attaque et en défense au rasoir.

★ ÉTAPE 4 : Conditionnement et habiletés spécifiques au sport ; en équipe
- AUCUN CONTACT; AUCUNE RÉELLE;
- Reprendre les pratiques et les durées d'entraînement habituelles;
- Pratiquer les passes et les lancers en équipe, et revoir les tactiques en défensive, en attaque et en contre-attaque.

★ ÉTAPE 5 : Pratique complète avec contact physique
- Revoir et pratiquer les techniques de jeu de tête;
- Reprendre l'entraînement complet pour retrouver votre place dans l'alignement. Si vous arrivez à la fin d'un entraînement sans symptômes, vous êtes prêt pour un retour à la compétition. Discutez avec l'entraîneur de votre retour au jeu;
- Les entraîneurs doivent s'assurer que l'athlète est revenu à son niveau de jeu habituel et qu'il a confiance en ses moyens pour reprendre le jeu.

★ ÉTAPE 6 : Retour à la compétition
When to refer

- Worsening/concerning symptoms
- Persistent symptoms (> 10 days)
- Prolonged LOC (> 1 minute)
- Elite athletes (> 6 hours/week)
- Multiple concussions
- Risk factors
- Migraine, premorbid conditions
MCH Trauma Program’s MTBI Clinic

- Team with clinical expertise
- Comprehensive and proactive approach
- Evidence-based
MCH’s MTBI CLINIC

- Inter-professional approach
Novel management strategies

- Active rehabilitation at 1 month
Medical consultant to MTBI clinic

Confirm diagnosis

“I just wanted to confirm the diagnosis you made at the cocktail party.”
Medical consultant to MTBI clinic

- Confirm diagnosis
- Establish a patient-centered plan
Headache
Novel management strategies

- Tailored headache management
  - Migraine action plan
  - Out-patient maxeran IV
  - Peripheral nerve blocks
Acute Head Injury

Diagnose concussion/mild TBI
1. Symptoms—somatic (ex, headache), cognitive (ex, feeling like in a fog) and/or emotional symptoms (ex, lability);
2. Physical signs (ex, loss of consciousness (LOC), amnesia);
3. Behavioural changes (ex, irritability);
4. Cognitive impairment (ex, slowed reaction times);
5. Sleep disturbance (ex, insomnia).

Check for red flags:
- Altered mental status
- Focal neurological symptoms or deficits
- Progressively worsening headache pattern
- Intractable headache
- Thunderclap headaches
- Headaches induced by position or vasalva maneuver
- Headaches with atypical features failing to conform to common headache phenotype
- Fever or other constitutional symptoms
- Persistent rhinorhea (possible CSF leak)

Box A
- Encourage rest
- NSAIDs at appropriate dose (ex. Ibuprofen) every 6 hours as needed for 3-5 days. Then no more than 2-3 days/week

Box B
- If severe pain (>6/10), acute abortive therapy Ex. Maxeran IV (may repeat x 3 doses), or prochlorperazine IV

Box C
- As per Box A and ensure not using >2-3 days week
- If migraine features and NSAIDs not effective, consider trial of triptan. (ex. Axert, Maxalt)
- Consider acute abortive therapy if moderate/severe pain (see Box B)

Box D

Box E
- Keep headache diary
- Lifestyle modifications; balanced diet & avoid skipping meals, hydration, and sleep hygiene (5-6 hrs/night restorative sleep)
- Consider biofeedback or other behavioral therapies

Box F
If concussion symptoms persist after approximately 2 weeks, refer to inter-disciplinary concussion program

Headache Management

Box G
- Trial of acute abortive therapy (see Box B)
- Consider short course of steroids, especially if medication overuse
- Consider option(s) in Box C not yet tried. Note that if triptan tried without effect, try alternate
- Address lifestyle issues (Box E)
- Identify and treat comorbidities (ex, depression, anxiety, insomnia).

Box H
Start prophylaxis or try an alternate medication if previous 2-3 month trial was ineffective at target dose or maximum tolerated dose:
- Elavil
- Gabapentin
- Topamax
- Melatonin if insomnia
If not improving, refer to neurology

Montreal Children's Hospital Concussion Kit

At each visit, reassess for headache red flags for structural traumatic brain/spine injury. If concern, obtain MRI over CT if possible.
# Outpatient headache management

## Abortive

<table>
<thead>
<tr>
<th>Medication</th>
<th>Age Range</th>
<th>Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxalt</td>
<td>Ages 6-17</td>
<td>5-10 mg (40 lbs)</td>
</tr>
<tr>
<td>Axert</td>
<td>Ages 12-17</td>
<td>12.5 mg</td>
</tr>
</tbody>
</table>

## Prophylaxis

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dosage</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B2</td>
<td>200-400 mg</td>
<td>Once daily</td>
</tr>
<tr>
<td>Amitriptyline</td>
<td>10 mg</td>
<td>Every evening</td>
</tr>
</tbody>
</table>
Insomnia

- Sleep hygiene
- Melatonin 3-5 mg qhs
Treat for status migrainosis

- Medical day hospital
- Emergency department
Nerve blocks for headaches

- Consensus recommendations 2013
  - Abortive and preventative
  - Long-lasting effect
  - Various headaches types
Headache types

- Migraine
- Cluster
- Chronic daily
- Secondary headaches
  - Cervicogenic
  - Post-traumatic
Greater occipital nerve
Obliquus capitis inferior muscle
Semispinalis Capitis Muscle
Anatomy 101

Trapezius Aponeurosis
~ 1/5 distance
 Technique
Nerve blocks and MTBI

Tobin et al. (2012)
- Adults (n=10)
- 86% reduction in headache intensity

Hecht (2004)
- First detailed series in mTBI (n=10)
- Adults > 18 years of age (mean 37)
Hecht (2004)

- **Good response**
  - Resolution of pain or relief longer than anesthetic effect of block
  - Requested another block

- **Partial response**
  - Relief < 24 hours

- **No response**
  - No effect
MCH Experience: 2012-2013

- Retrospective review of nerve blocks
- Headache and occipital neuralgia
- Lidocaine 2% with epinephrine

30-Gauge ½ inch needle, cc/site, then ice to site(s)
### Demographics (n=30 injuries, 28 patients)

- **Mean Age**: 14.6 years (10-17)
- **Female**: 80%
- **FH Migraine**: 76.7%
- **Past MTBIs**: 56.7%
- **Sport-related MTBI**: 76.7%
- **Neuroimaging**: 46.7%
- **Mean PCS**: 45.2
Characteristics of nerve blocks

- Mean days from injury to 1st block: 70 days
- Single nerve blocks: 47%
- Mean No nerve blocks (range): 2 (1-6)
- Peripheral nerves of the scalp blocked:
  - GON: 27%
  - GON+SO: 60%
  - GON+LON±SO: 14%
Effects of nerve blocks

- Mean pre-headache intensity: 5.6
- Mean post-headache intensity: 0.4

Mean percent reduction: 93%
Immediate headache response

- **Completely resolved** 71%
  - Headache 0/10
- **Relieved** 24%
  - Headache 1-2/10
- **Poor** 5%
  - Headache ≥3/10
Therapeutic effect of nerve block

- **Good**: 93%
  - Relief ≥24 hours
  - Requested another block
- **Partial**: 7%
  - Relief < 24 hours
- **None**: 0%
Dear Doctor,
we think you should cut open Colleen’s head and put an ice pack and ice in there. That should help her freeze.

Love
Maddy + Mia

Take care of Her!

Posted with Colleen’s consent.
“I would like to have another block (the maxeran doesn't help). When do you think it would be possible?”

“Suite au traitements … le bloc a eu un effet positif sur ses mots de tete. Il a réussi à faire 3 périodes en classe…”

“<A> has been headache free since the procedure on Friday evening. We are all very happy.”
Satisfaction survey (n=22/28)

- Relieved headache immediately: 83%
- Response in the following days/weeks:
  - Improved: 83%
  - Resolved: 61%
  - Cured: 26%
- Improved quality of life: 74%
- Would recommend to friend: 91%
Satisfaction Survey (n=22/28)

Which treatment would you prefer?
- Metoclopramide
- Nerve block
- Both
- Neither
**Satisfaction survey** *(n=22/28)*

<table>
<thead>
<tr>
<th>Would recommend to friend:</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Metoclopramide</td>
<td>35%</td>
</tr>
<tr>
<td>Nerve block</td>
<td>88%</td>
</tr>
</tbody>
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<tr>
<td>Metoclopramide</td>
<td>6%</td>
</tr>
<tr>
<td>Nerve block</td>
<td>76%</td>
</tr>
<tr>
<td>Both</td>
<td>6%</td>
</tr>
<tr>
<td>Neither</td>
<td>12%</td>
</tr>
</tbody>
</table>
## Metoclopramide versus Nerve Block

<table>
<thead>
<tr>
<th></th>
<th>Metoclopramide</th>
<th>Nerve block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent reduction in headache intensity</td>
<td>74%</td>
<td>93%</td>
</tr>
<tr>
<td>Proportion completely resolved headache</td>
<td>28%</td>
<td>71%</td>
</tr>
</tbody>
</table>
Laughing versus drowsy

Nerve Block  Maxeran
Consider…
Take home
Take home

- Concussion have morbidity ... suffering x 1-2 months
- Rest is hallmark of therapy
- Graded return to school/play
- Inter-professional approach for complicated/persistent
Future directions

- What treatment(s) are most effective for post-concussion headaches?
  - RCT

- Can we predict who will be slow to recover?
  - Roger Zemeck, Isabelle Gagnon and Sasha Dubrovsky
Questions/comments

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- www.thechildren.com/trauma