Post-Concussion Effects in Children

School Nurse Curriculum
2009
The focus of this information is children who have previously been evaluated and have an established diagnosis of concussion. The information contained herein is not intended for acute concussion management.


The most common head injury in sports is concussion. The study of mild concussion is particularly important to younger athletes as this age group represents a large group of competitive athletes who are at risk for injury. While a child who experiences a mild concussion often feels well, passes basic sideline tests of memory, and wishes to return to play immediately, this can prove harmful in the long term. Current data indicates that concussion signs and symptoms can evolve over time and may not be present at the time of injury. (Lovell, M. R., Collins, et al, 2004)

**Concussion – Other Terms**

Other terms for concussive injuries:
- Traumatic Brain Injury (TBI)
- Mild Traumatic Brain Injury (MTBI)
- Closed head injury (CHI)
- “Bell Ringer” or “Ding” injury
- Post-concussion syndrome
- Second-impact syndrome
Every year in the United States 1.5 million individuals incur a traumatic brain injury. Injuries may be intentional or accidental. An estimated 5.6% of American high-school football players sustain a concussion in a given season. (CDC & NCICP, 2006)

<table>
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<tr>
<th>Concussion - Demographics</th>
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<tr>
<td><strong>Incidence</strong></td>
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<tr>
<td>• 0-14 years of age</td>
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<tr>
<td>– 475,000 children with TBI</td>
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<td>– 90% require ED visit</td>
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<td>– 3-5% of high school athletic injuries</td>
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<td>• 0-4 years</td>
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<td>– Falls are leading cause of TBI</td>
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<tr>
<td>• Other causes</td>
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<td>– MVA, assault, hitting an object</td>
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Features of a concussion can be obvious or subtle. A loss of consciousness can be brief or prolonged. More subtle features may be a vacant look, delayed verbal and/or motor response, difficulty with attention, focusing and confusion, disorientation, poor coordination and speech, memory, or emotional lability.

Concussion - Classifications

Concussion Classifications (AAN, 1997)

- **Grade I** – Transient confusion, no LOC, mental status abnormalities last less than 15 minutes
- **Grade II** – Transient confusion without LOC, mental status abnormalities last more than 15 minutes
- **Grade III** – Any LOC for any period of time
Concussion - Issues

Three key issues to be addressed at time of injury and after:
1. Appropriate management at time of injury to identify potential neurosurgical emergencies
2. Prevention of catastrophic outcome related to acute brain swelling
3. Avoidance of cumulative brain injury related to repeated concussions

Kelly and Rosenberg (1997)
A grade I concussion can cause difficulties with memory and concentration. There may be “fogginess,” difficulty with concentration, slower processing speeds, and slower reaction time. Mild symptoms can be associated with a Glasgow Coma Scale rating of 15 and a negative CT.

In younger children, symptoms of concussion can be subtle and difficult to elicit. These symptoms may include irritability, fussiness, inconsolability, changes in sleep/nap patterns (increased or decreased), vomiting, balance problems, apathy, or lack of interest in play activities.

Late symptoms can last days to weeks to months. It is not uncommon for an adolescent to have post-concussion headaches and other symptoms for 6 months to one year after the concussion. Continuation of late symptoms is called post-concussion syndrome.
Current theory postulates that the younger brain is more vulnerable to the disruption of auto-regulatory functions. These include decreased myelination, a greater head to body ration, and thinner cranial bones, all of which provide less protection. (Theye and Mueller, 2004)

Acceleration, deceleration, and rotation stresses and strains the brain tissue and vasculature. Additionally, children have less well developed shoulder and neck musculature than adults, making them less able to transfer forceful energy from the head throughout the body, possibly increasing the risk of concussion. (Kirkwood, Yeates, & Wilson, 2006)
Pathophysiology

- Metabolic and ionic changes occur in white matter, increasing glucose demand and decreasing cerebral blood flow.

- Swelling and inflammation occur which cause symptoms which may or may not be visible on CT or MRI.
While sudden death from second impact syndrome occurs infrequently, it is a real risk. Symptoms should be completely resolved prior to resuming physical activity. Often a gradual return to physical activity is recommended, assessing head pain, endurance, fatigue, and systematically working up to prior level of function. Parents, coaches, and children should be aware of this serious risk.

The process of second impact syndrome is thought to involve loss of autoregulation of the brain’s blood supply, leading to vascular engorgement which can lead to increased intracranial pressure.
Second Impact Syndrome

- Cumulative neuro-cognitive, somatic, and neurophysiologic effect of repeated concussions
- Return to play must be approached with caution
- Documented almost exclusively in immature brains, young athletes at heightened risk for catastrophic consequences
Various professional organizations (AAN, AAP, CDC) have attempted to summarize return to play guidelines in a reproducible manner. However, after many years of research, discussion, evidence-based reports, etc. the current standard remains individualized management by the healthcare provider for the concussed child.
Return to Play

When to Return to Play

- No signs or symptoms of any kind are apparent at rest or during exertion
- Neurologic examination is normal
- Neuroimaging is unremarkable when performed
- “When in doubt, sit them out.”

(Kirkwood, Yeates, Wilson, 2006)
Return to Play

How to Return to Play

• Light aerobic activity
  – Walking, stationary bike

• Sport-specific activities and training
  – Running, skating

• Non-contact training drills

• Full contact practice training after medical clearance

• Game play

(Kirkwood, Yeates, Wilson, 2006)
Process Oriented Post-Concussion Assessment for the School Nurse
The Healthy Learner Model (HLM) for Student Chronic Condition Management is used to bridge gaps observed in medical models of disease management and programs that focus only on the environment at school. The Healthy Learner Model is an integrated, coordinated effort to optimize the health status and support the academic success of children with chronic conditions (Erickson, Splett, Mullett & Heiman, 2006).

The synergistic elements of the HLM are: 1) leadership, 2) evidenced based nursing practice, 3) capacity building, 4) resource nurse, 5) the healthy learner, 6) partnership with parents and 7) partnership with health care providers. Leadership, from the school and community, is responsible for promoting the vision across systems and securing the resources needed to manage the chronic illness. Evidence-based practice in nursing is the process of combining the best evidence available with nursing experience and patient/family preferences to determine the interventions for optimum outcomes (Adams & McCarthy, 2005).

The aim of the HLM is to enable students with chronic conditions to be healthy, in school, and ready to learn (Erickson, Splett, Mullett & Heiman, 2006). The HLM has been replicated for use with asthma management and ADHD management.
Child Neurology Process-Oriented Triage Model

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Description of Symptoms

- What symptom(s) is/are the student demonstrating?
- Does the child have a diagnosis of concussion or other neurologic disorder? What is the classification?
- Is the child on medication?
- What is seen at school and under what circumstances?
Description of Symptoms

Acute vs. Chronic
- When did injury occur?
- Concussion classification
- Initial symptoms
- Return to baseline neurologic functioning
- Are symptoms absent, improved, unchanged, or worse?
Length of symptoms depends on degree of initial injury. Neuro-cognitive testing is often helpful in determining the specific effects of a TBI, especially in situations where memory or academic performance is affected.

New onset of symptoms such as seizures, vision change, ataxia, vomiting warrant immediate evaluation at the PCP or in an Emergency Department setting.

**Description of Symptoms**

Has there been an acute deterioration of symptoms?

- Seizure, confusion, lethargy, ataxia, nausea, vomiting, irritability, sudden onset severe headache, blurred vision, etc.
- **If so, seek immediate medical attention**
Abortive (rescue) or prophylactic headache medications are frequently used to treat long-lasting post-concussive headaches. As with general headache management, overuse of OTC analgesics such as acetaminophen or ibuprofen can cause drug induced refractory or “rebound” headaches. If OTC analgesics are being used frequently, more than 3-4 times per week, the child should be evaluated by a child neurology practitioner to assess if they are a candidate for prophylactic medication.
Close review of the past medical history is important to identify any previous or family history of a bleeding disorder which can increase the risk of long-term sequelae and impact management decisions related to safe resumption of sports and other activities. If a child has a history of migraine, epilepsy, or behavioral or psychiatric issues, these may be aggravated by the concussion.

Assessment of general health and psychosocial issues is also important. Sleep patterns are particularly important in the acute and chronic post-concussion phases. Poor sleep can trigger headaches and exacerbate difficulties with attention and focus. Excessive sleep can be indicative of depression or a serious physical problem. Healing requires physical and cognitive rest so good sleep hygiene should be strongly emphasized.

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**Medical Update-Chronic**

- History of past head injury or concussion
  - When?
  - Duration of symptoms, length of recovery
- Bleeding disorder
- Other physical or medical co-morbidities
- CT or MRI imaging
  - Other relevant labs or procedures
- Serial neuro-psychologic testing
Signs of depression or coping difficulties, particularly in children with prolonged symptoms, may require psychologic intervention.

Also, depending on the circumstances of the head injury, some children may experience symptoms of post-traumatic stress and require specialized behavioral or psychiatric intervention.

Medical Update – Action Plan

• Discuss with family
  – Safety precautions for activities and sports
  – Return to play guidelines
  – Medications – use, overuse
  – Risk of repeat head injury

• Consult with provider re:
  – Medication side effects, interactions
  – Improvement or exacerbation of symptoms
  – Status of co-morbidities, concurrent illnesses
  – Need for acute intervention
Behavioral changes occur frequently in children with concussion. Symptoms may include anxiety, frustration, impulsivity, emotional outbursts, tantrums, sadness, lack of interest, aggression. Assessment of parenting skills is important in relation to behavior issues, including typical response and management of the behavior, child’s response to discipline, and whether the family is receiving counseling or other supportive care.
Co-morbidities diagnosed prior to concussion may be exacerbated by the concussion and/or its treatment.
Family Dynamics and Coping

Identify and Describe:

- Change in family dynamics or structure
- Financial or insurance issues
- Parent/patient level of concern and understanding about injury and return to “normal”
Long term changes usually become evident in the first year after injury. These changes can be overwhelming to the child and family. There may be a grieving process as it is unclear how long the symptoms will last, whether they will improve, and whether the child will return to "normal".

Family Dynamics and Coping

- Guilt and grief can be overwhelming to families
- Families experience burden of medications, multiple health care practitioners, imaging, lab, neuro-psychiatric testing, etc.
- Assessment of knowledge, level of anxiety, and perception of the concussion can be helpful
Family Dynamics and Coping – Action Plan

- Discuss nature and etiology of concussion
  - Strategies to address current and long term issues, medication and return to play
- Provide information on nutritional, financial, insurance assistance as indicated
- Refer to school counselor as indicated
- Encourage use of community resources
- Update PCP and or child neurology provider regarding health or other issues
Depending on the degree of academic difficulty after the concussion, children may need temporary or prolonged special academic interventions. The goal is to optimize the child’s potential for learning in a supportive environment. If specific academic performance issues persist, full educational testing may be indicated to identify specific deficits or disabilities.
Strategies to Support Transition Back to School After Concussion (Kirkwood, Yeates, Wilson, 2006)

Initial Transitional Support
- Alert school personnel to injury
- Gradual reintegration into school
- Not expected to complete ALL work during absence
- Extra assistance to facilitate completion of make-up work

General School Based Support
- Ensure rest time and breaks as needed
- Reduce overall homework and class workload
- Reduce cognitively demanding in-school tasks
  (E.g. no more than one test per day)
This list is not all-inclusive. Each situation provides individual challenges.
An interval school assessment should include the child’s current level of academic performance (grades), ability to focus, status of learning disabilities, behavior or social issues, significant changes and response to educational interventions and specialized services or therapies.

If a child is medicated for attention, focusing, or behavioral issues, assessment should include a standardized questionnaire or teacher’s report to gauge response and efficacy.

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**School and Therapy – Action Plan**

- Obtain/verify exchange of information consent is present and up to date
- Initiate IEP/504 or other plan as appropriate
- Refer to school liaison, advocacy sources
- Keep teachers and other school personnel informed of student status
- Update school management plan
  - Modified PE, sports exemption
The majority of research in the 21st century focuses on baseline and post-injury neuropsychological testing as the “gold standard” of post injury management and the return to play decision. Along with this, all critiqued studies and anecdotal or non-research articles in the general literature agree that a gradual return to play is recommended, and any relapse of symptoms regresses the athlete to a previous step, necessarily prolonging return to play until asymptomatic at rest and with activity.
Practice Recommendations

- Neuro-imaging and computerized neuro-psych testing becoming standard of practice
- Increased knowledge of biomechanics of head injury necessary
- Return to Play instructions not “one size fits all”
- Current trend based on objective assessments is *individualized concussion management*
Practice Recommendations

Return to Play Guidelines:

Rule #1:
“Complete resolution of concussion symptoms at rest and with exertion.”

Rule #2
“You can’t change rule #1.”

(Huhn, 2003)
Coaches, players, parents, and health care providers must fully understand the short and long term medical issues involved in concussion. Many athletes do not consider concussion to be a serious problem that could result in death or permanent disability (Harmon, 1999; Meehan & Bachur, 2009). Education of all involved may lead to increased reporting and proper management of sports-related concussion in children and adolescents. The Centers for Disease Control and Prevention (CDC, 2007) produced a toolkit “Heads Up: Concussion in High School Sports” available for free through the CDC website. Prevention of concussion is difficult, if not impossible. Newer helmet technology is currently under intense scrutiny, assessing whether neck musculature is strengthened by bracing neck muscles prior to impact (Russo Buzzini & Guskiewicz, 2006). In conclusion, rule enforcement, promotion of fair play, and respect for opponents must be encouraged to avoid situations in which concussions can occur (Meehan & Bachur, 2009).
Research Question:
In children and adolescents (ages 8-19), are implementation of return-to-play guidelines following a sports-related concussion as effective as an individualized approach in minimizing morbidity and mortality associated with mild concussive brain injury?

Answer: No
Provider Resources

Brain Injury Resource Center
www.headinjury.com

CDC
www.cdc.gov/features/concussion

American Academy of Pediatrics
www.aap.org

American Academy of Neurology
www.aan.org

Concussion Management
www.impacttest.com