Neurological Consequences Of Concussion and Blunt Head Trauma

Karen Guzi, RN, MSN, ACNS-BC
Clinical Nurse Specialist
Emergency Services Institute
Main, Avon and Twinsburg Campus
Cleveland Clinic
Objectives

• Apply guidelines for evaluation and management of the concussion and blunt head trauma patient
  – Acute, sub acute and chronic settings

• Identify the red flags and risk factors for recurrent concussion and other complications of concussion

• Identify how age and environment will impact the evaluation of the concussive patient with concussion and other blunt head trauma
Age Specific Considerations

• Most common head injuries based on age group per NIH (National Institute Of Health)

  — Children Up to 4 years old
  — Adolescents 15-19 years
  — Adults 65 years and older
Age Specific Considerations

• Pediatrics
  – Brain is still developing
  – Neck and shoulder musculature less developed
  – Very young children with mild-to-severe traumatic brain injury as measured by the Glasgow Coma Scale are at risk for global cognitive deficits more than a year after the time of injury.

  – Images with permission of thinkstock.com.
Age Specific Considerations

- Adolescents
  - Post concussion
  - Not largely studied
  - Underreported
  - Mild concussion

Images with permission of thinkstock.com.
Age Specific Considerations

– Adults
Age Specific Considerations

• Geriatric patients
  — Associated preexisting medical conditions
  — Poor relative physiologic reserve
  — Higher mortality rates
  — Poorer long-term functional outcomes

• Decrease in sensory and mobility

• Need for clear baseline (pre-injury) status

• Images with permission of thinkstock.com
Definitions

• Traumatic brain injury (TBI)
  – Form of acquired brain injury
  – Occurs when a sudden trauma causes damage to the brain.
Anatomy and Physiology

Images with permission of thinkstock.com
Two Primary Mechanisms of Head Injury

• Linear
  – Example: Quarterback falls to the ground and hits the back of his head
  – The falling motion propels the brain in a straight line downward

• Rotational
  – Example: When a football player is tackled, his head may strike an opponent’s knee
  – This contact to the head can cause a rotational motion
Angular Forces

Images retrieved:
Mechanism of Closed Head Injury

Deceleration

Acceleration

Head thrown backward while brain hits front of skull

Head thrown forward while brain hits back of skull

Angular deceleration

Rotational force centered on midbrain and thalamus

Fixed object

Midbrain
Cervical Injury and Neck Pain

- Consider neck injury on all head injury patients

- Consider head injury on all neck injury patients
Types of Injury

• Contusion
  – Bruise to the brain or collection of blood under the skin

• Cerebral contusions
  – Associated with prolonged loss of consciousness
  – Includes higher mortality
Types of Injury

• Hematoma
  – Collection of blood → intracranial hematoma
  – Occurs when blood vessel ruptures
  – Within brain or between skull and brain
  – Collection of blood (hematoma) compresses brain tissue
Types of Injury

- Skull fractures
  - Break in cranial bones
  - Closed, open, depressed or hairline
  - Basilar fracture have increase risk for cerebrospinal infection

Types of skull fracture

Image from thinkstock.com
Hemorrhage

• Blood vessel inside the brain is disrupted
  – Leaks, tears, ruptures
  – Blood gets into the brain tissue
  – Causes inflammation and swelling

• Blood vessels on the surface of the brain breaks
  – Blood can collect between brain and surrounding membranes
  – Results in pressure on brain

• Both inflammation and pressure can damage the brain
Types of Injury

• Facial trauma

• Consider…

• Head injury on ALL patients presenting with facial trauma
Moderate to Severe Traumatic Brain Injury (TBI)

• Signs of moderate or severe TBI
  – Receive medical attention as soon as possible

• Little can be done to reverse the initial brain damage caused by trauma
  – Medical personnel should stabilize an individual with TBI
  – Focus on preventing further injury
Support for Moderate to Severe TBI

• Primary
  – ABC – airway breathing and circulation (also depending on mechanism of injury think Cervical spine immobilization)
  – Proper oxygenation
  – Maintain adequate blood flow
  – Maintain blood pressure

• Imaging help to determine diagnosis and prognosis
  – Establish a baseline study

• Moderate to severe cases
  – Imaging of choice is CT scan
Brain Stem Herniation

Expanding intracerebral bleed
Subdural space
Expanding subdural bleed
Brain
Brainstem
Skull
Dura mater
Epidural space
Concussion and Blunt Head Injury

• **Controversy** amongst professional groups about the definitions of these injuries

• **Agree** that even a **mild injury** can have life long impact on a persons life

• **Agree** that **prevention** is the optimal management approach

• **Agree** that **early recognition and appropriate management** and referral once injured is key
Types of Injury

• Concussion
  — Complex pathophysiologic process affecting the brain induced by trauma or biomechanical forces clinical syndrome characterized by immediate and transient alteration in brain function, including alteration of mental status and level of consciousness, resulting from mechanical force or trauma

  Concussion in sports group (2010)

• FUNCTIONAL not STRUCTURAL injury
Diffuse Axonal Injury

• White Matter of the Brain
  – Nerve cells are connected by axons (long projections of nerve cells resembling insulated wiring) which connect neurons to other neurons
Acute Head Injury

- Evolving Injury

- With blunt head trauma many forces are acting on the brain

- These forces can cause twisting and shearing of the brain tissues

- With enough twisting of the tissues, the long, delicate axons can tear or break

- This axonal injury prevents the normal electrical impulses from passing down the axon normally
Changes after Concussion

- Abrupt neuronal depolarization
- Suppression of neuronal activity
- Impaired axonal function
- Efflux of K+ into extracellular space
- Subsequent release of glutamate $\rightarrow$ more K+ release
- Release of excitatory neurotransmitters
- Altered glucose metabolism and cerebral flow
Concussion and Mild TBI

What is a Concussion?
A concussion is a type of traumatic brain injury, or TBI, caused by a bump, blow, or jolt to the head that can change the way your brain normally works. Concussions can also occur from a fall or a blow to the body that causes the head and brain to move quickly back and forth.

Health care professionals may describe a concussion as a "mild" brain injury because concussions are usually not life-threatening. Even so, their effects can be serious.

- What are the Signs and Symptoms of Concussion?
- What Should I Do If a Concussion Occurs?
- What Can I do to Help Feel Better After a Concussion?
- What Can I do to Help Prevent Concussion and other forms of TBI?
- Where Can I Find Videos, Podcasts, and Other Media?
- Where Can I Find Support and Additional Resources?
Additional Resources

• Website geared toward caregivers

• http://www.cdc.gov/concussion/HeadsUp/clinicians/
Grading of Concussion

• “There is no such thing as a minor concussion”
  – American Academy of Neurology.

• Grade 1
  – Transient confusion
  – NO loss of consciousness
  – Concussion symptoms clear in less than 15 minutes

• Management
  – Remove from contest
  – Examine immediately and at 5 minute intervals for the development of mental status abnormalities or post-concussive syndrome at rest and with exertion.
  – May return to contest if mental status abnormalities or post-concussive symptoms clear within 15 minutes.
Grading of Concussion

• Grade 2
  – Transient confusion
  – NO loss of consciousness
  – Concussion symptoms or mental status abnormalities last longer than 15 minutes

• Management
  – Remove from contest: disallow return that day.
  – Examine on site frequently for signs of evolving intracranial pathology
  – A trained person should re-examine the athlete the following day
  – A physician should perform a neurologic exam to clear the athlete for return to play after 1 full asymptomatic week at rest and with exertion
Grading of Concussion

• Grade 3
  – Any loss of consciousness
  – Either brief (seconds) or prolonged (minutes)

• Management
  – Transport from the field to the nearest ED by ambulance if still unconscious or worrisome signs are detected (with cervical spine immobilization, if indicated)
  – A thorough neurologic evaluation should be performed emergently, including neuro-imaging procedures when indicated.
  – Admit to hospital if any signs of pathology are detected or if the mental status remains abnormal.

• ALL are Traumatic Brain Injuries
Diagnosis and Management

• Management of head Injury
  – Ongoing process due to the injury being an evolving process

• Acute
  – Immediately after injury to 7-10 days post injury

• Sub-acute
  – 7-10 days post injury to 28 days or even weeks after injury

• Chronic
  – Greater than four to six months post injury
Diagnosis and Management

• Post injury evaluation
  – Dynamic and ongoing
  – Immediately post injury (on site)
  – ABC - airway breathing and circulation
  – Immediate transport from scene with suspected Cervical spine injury, airway issue, decreasing loss of consciousness (LOC) or focal neurological deficit
  – History: LOC- loss of consciousness (Immediate, delayed, length)
  – Mechanism of injury
  – Neurological assessment (current and reported baseline)
    – Moving away from grading to an individual neurological assessment with reference to baseline (pre injury) function
    – Again after 30 minutes
  – Close observation and monitoring for next 24-48 hours
    – Minimal 2 hour observation before sending home
On Scene Evaluation

• Conducted using systematic approach, recognized tools
  – Discrepancies between specialty groups exits
  – GCS    Glasgow Coma Scale
  – SCAT   Sports Concussion Assessment Tool
  – ACE    Acute Concussive Evaluation (Care Plan)

• Completed by coach or coworker
  – Specific training in concussion

• Consistent
  – Use of focal neurological deficit elevates concern
  – Younger is cause for conservative management
## Glasgow Coma Scale

<table>
<thead>
<tr>
<th>Eye Opening</th>
<th>Verbal</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Follows commands</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Oriented</td>
<td>Localizes</td>
</tr>
<tr>
<td>4</td>
<td>Spontaneous</td>
<td>Confused</td>
</tr>
<tr>
<td>3</td>
<td>To verbal</td>
<td>Inappropriate words</td>
</tr>
<tr>
<td>2</td>
<td>To pain</td>
<td>Nonspecific sounds</td>
</tr>
<tr>
<td>1</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

---

*Image courtesy of Cleveland Clinic.*
## Modified GCS for Infants

<table>
<thead>
<tr>
<th>Eye Opening</th>
<th>Verbal</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Coos, babbles</td>
<td>Spontaneous</td>
</tr>
<tr>
<td>5</td>
<td>To speech</td>
<td>Withdraws to pain</td>
</tr>
<tr>
<td>4</td>
<td>Spontaneous</td>
<td>Irritable, cries</td>
</tr>
<tr>
<td>3</td>
<td>To pain</td>
<td>Cries to pain</td>
</tr>
<tr>
<td>2</td>
<td>To pain</td>
<td>Moans to pain</td>
</tr>
<tr>
<td>1</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Symptom Evaluation

How do you feel?

You should score yourself on the following symptoms, based on how you feel now.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Pressure in head&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck Pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blurred vision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling like &quot;in a fog&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Don’t feel right&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue or low energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drowsiness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trouble falling asleep or difficulty awaking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More emotional</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imitability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sadness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Namor or Anxious</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total number of symptoms (maximum possible 22)

Symptom severity score

Not all scores in table, maximum possible (22 x 6 = 132)

Do the symptoms get worse with mental activity?

0 Y  N

Do the symptoms get worse with physical activity?

0 Y  N

Overall rating

0 none different 1 very different

What is the SCAT2?

This tool represents a standardized method of evaluating injured athletes for concussion and can be used in athletes aged from 10 years and older. It supersedes the original SCAT published in 2005. This tool also enables the calculation of the Standardized Assessment of Concussion (SACH) score and the Maddocks questions for sideline concussion assessment.

Instructions for using the SCAT2

The SCAT is designed for the use of medical and health professionals. Preadmission baseline testing with the SCAT2 can be helpful in interpreting the patient’s responses. Words in italics throughout the SCAT2 are the instructions given to the athlete by the tester.

This tool may be freely copied for distribution to individuals, teams, and organizations.

What is a concussion?

A concussion is a disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of nonspecific symptoms (like those listed below) and often does not involve loss of consciousness. Concussion should be suspected in the presence of any one or more of the following:

- Symptoms (such as headache), or
- Physical signs (such as amnesia), or
- Impaired brain function (e.g. confusion), or
- Abnormal behavior.

Any athlete with a suspected concussion should be removed from play, medically monitored, for determination (0.4a., should not be left alone) and should not drive a motor vehicle.
Balance examination

Balance testing: I am now going to test your balance. Please take your shoes off, roll up your pant legs above ankle (if applicable) and remove any ankle taping (if applicable). This test will consist of these twenty second tests with different stance.

(a) Double leg stance: You are standing firmly with your feet together with your hands on your hips and your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes.

(b) Single leg stance: If you want to kick a ball, which foot would you use? This is the dominant foot. Now stand on your non-dominant foot. The dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes.

(c) Tandem stance: “Look stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed between both feet. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes.

Balance testing - types of errors
1. Hands lifted off the chair
2. Opening eyes
3. Slip, stumble, or fall
4. Moving hips into >30 degrees abduction
5. Sitting, falling, or fall
6. Remaining out of test position >5 sec.

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the athlete. The examiner will begin counting errors only after the individual has assumed the proper start position. The modified BBS is calculated by adding one error point for each error during the three 20-second tests. The maximum total number of errors for any single condition is 10. If an athlete commits multiple errors simultaneously, only one error is recorded but the athlete should quickly return to the test position, and continue the exam once subject is set. Subjects that are unable to maintain the testing procedure for a minimum of five seconds at the start are assigned the highest possible score, ten, for that testing condition.

Which foot was tested: Left Right

Cognitive assessment

Standardized Assessment of Concussion (SAC)

Delayed recall
“Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order.”

Circle each word correctly recalled. Total score equals number of words recalled.

| Word | Alternative word
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>elbow</td>
<td>candle</td>
</tr>
<tr>
<td>apple</td>
<td>paper</td>
</tr>
<tr>
<td>carpet</td>
<td>sugar</td>
</tr>
<tr>
<td>saddle</td>
<td>sandwich</td>
</tr>
<tr>
<td>bubble</td>
<td>wagon</td>
</tr>
</tbody>
</table>

Delayed recall score: of 5

Overall score

Set domain | Score
Symptom score | of 22
Physical signs score | of 2
Glasgow Coma score (E + V + M) | of 15
Balance examination score | of 10
Coordination score | of 5
Subtotal | of 30
Orientation score | of 5
Immediate memory score | of 5
Concentration score | of 5
Delayed recall score | of 5
SAC total | of 10
Maddocks Score | of 5

Definitive normative data for a SAC2 “cut-off” score is not available at this time and will be developed in prospective studies. Embedded within the SAC2 is the SAC score that can be utilized separately in concussion management. The scoring system also takes on particular clinical significance during serial assessment where it can be used to document either a decline or an improvement in neurological functioning.

Scoring data from the SAC2 or SAC should not be used as a stand alone method to diagnose concussion, measure recovery or make decisions about an athlete’s readiness to return to competition after concussion.

Athlete Information

Signs to watch for

Any athlete suspected of having a concussion should be removed from play, and then seek medical evaluation.

- Problems could arise over the first 24-48 hours. You should not be left alone and must go to hospital at once if:
  - You have a headache that gets worse
  - You are very drowsy or can’t be awakened (woken up)
  - You can’t recognize people or places
  - You have repeated vomiting
  - Behave unusually or seem confused; are very irritable
  - Have seizures; arms and legs jerk uncontrollably
  - Have weak or numb arms or legs
  - Are unsteady on your feet; have slurred speech

Remember, it is better to be safe. Consult your doctor after a suspected concussion.

Return to play

Athletes should not be returned to the same day of injury. When returning to athletes to play, they should follow a Baseline program, with stages of progression. For example:
1. Rest until asymptomatic (physical and mental rest)
2. Light aerobic exercise (e.g., stationary cycle)
3. Sports specific exercise
4. Non-contact training drills (start light resistance training)
5. Full contact training after medical clearance
6. Return to competition (game play)

There should be approximately 24 hours (or longer) for each stage and the athlete should return to stage 1 if symptoms recur. Resistance training should only be added in the later stages. Medical clearance should be given before return to play.

Additional comments

Concussion injury advice

This patient has received a injury to the head. A careful medical evaluation has been carried out and no sign of any serious complications has been found. It is expected that recovery will be rapid, but the patient will need monitoring for a further period by a responsible adult. Your treating physician will provide guidance as to this timeframe.

If you notice any change in behavior, vomiting, dizziness, worsening headache, double vision or excessive drowsiness, please telephone the clinic or the nearest hospital emergency department immediately.

Other important points:
- Rest and avoid strenuous activity for at least 24 hours
- No alcohol
- No sleeping tablets
- Use paracetamol or codeine for headache. Do not use aspirin or anti-inflammatory medication
- Do not drive until medically cleared
- Do not travel or play sport until medically cleared
2. Memory function

Failure to answer all questions correctly may suggest a concussion.

“At what venue are we at today?”
“Which half is it now?”
“Who scored last in this game?”
“What team did you play last week/game?”
“Did your team win the last game?”

3. Balance testing

Instructions for tandem stance

“Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. You should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes.”

Observe the athlete for 20 seconds. If they make more than 5 errors (such as lift their hands off their hips; open their eyes; lift their forefoot or heel; step, stumble, or fall; or remain out of the start position for more than 5 seconds) then this may suggest a concussion.

Any athlete with a suspected concussion should be IMMEDIATELY REMOVED FROM PLAY, urgently assessed medically, should not be left alone and should not drive a motor vehicle.
Evaluation and Monitoring

Criteria to evaluate function includes 4 categories

• Cognitive
• Somatic (physical/bodily symptoms)
• Sleep (not on scene)
• Emotions
Category of Function

• Cognitive
  — Confusion
  — Amnesia (ante grade or retrograde)

LOC immediately or delayed

Disorientation

Delayed or slowed thinking

Feeling “foggy”
Head Injury Category of Function

• Somatic
  – H/A (headache)
  – Dizzy
  – Blurry vision / visual changes
  – Decreasing balance / coordination
Category of Function

• Sleep
  – Increased Sleep
  – Decreased Sleep
  – Inability to fall asleep

• Not on scene evaluation
Category of Function

• Affective - Mood (usually not done on scene)
  – Emotionally labile
  – Sadness (associated depression)
  – Nervous or anxiety
  – Irritable
  – Fatigue
## Signs and Symptoms Of Concussion

### Table 1. Signs of Concussion

1. Vacant stare (dazed, befuddled facial expression)
2. Delayed responses (slow to answer questions or follow instructions)
3. Inattention (easily distracted or unable to track conversations)
4. Disorientation (walking in the wrong direction, unaware of time, date, place)
5. Slurred or incoherent speech (making disjointed or incomprehensible statements)
6. Incoordination (stumbling, inability to walk tandem/straight line)
7. Inappropriate emotionality (appearing distraught, crying for no apparent reason)
8. Memory problems (exhibited by athlete repeatedly asking a question that has already been answered or exhibiting memory deficits on the SAC or other formal mental status testing)
9. Loss of consciousness (paralytic coma, unresponsiveness to stimuli)

### Table 2. Symptoms of Concussion

**Early (minutes to hours)**
1. Headache
2. Dizziness or vertigo
3. Lack of awareness of surroundings
4. Muddled thinking
5. Nausea and vomiting

**Late (days to weeks)**
1. Persistent low-grade headache
2. Lightheadedness
3. Diminished attention and concentration
4. Poor memory
5. Easy fatigability
6. Irritability and low frustration tolerance
7. Intolerance of bright lights or difficulty focusing vision
8. Intolerance of loud noises, sometimes ringing in the ears
9. Anxiety and depressed mood
10. Sleep disturbance

---

Elevation of Concern

• Danger Signs in Adults
  – Headache that gets worse and does not go away
  – Weakness, numbness or decreased coordination
  – Repeated vomiting or nausea
  – Slurred speech
  – Unequal pupils
  – Convulsions or seizures
  – Cannot recognize people or places/disorientation
  – Getting more and more confused, restless, or agitated
  – Unusual behavior
    – Looks very drowsy or cannot be awakened
  – Lose consciousness
    – Brief loss of consciousness should be taken seriously
    – Person should be carefully monitored

• Danger Signs in Children
  – Have any of the danger signs for adults
  – Will not stop crying and cannot be consoled
  – Will not nurse or eat
Observation to Imaging

- Mild symptoms return to baseline, transient symptoms
- Improving, NO focal neurologic deficit
- Monitor

- Mild to moderate injuries may receive skull and neck x-rays to check for bone fractures or spinal instability

- Computed tomography (CT) scan based on symptoms
Imaging for Head Injury

• Current use of CT (computerized axial tomography scan) for minor head injury
  – Increasing rapidly
  – Highly variable
  – May be inefficient

• IF CT (computerized axial tomography scan) imaging is unavailable by availability or equipment failure
  – Patients with GCS 15 may be admitted for observation
Imaging Considerations

• No evidence to recommend MRI over CT in acute evaluation

• Non-contrast head CT
  – Indicated in patients with loss of consciousness or post traumatic amnesia
  – SHOULD be done in patients without loss of consciousness or post traumatic amnesia in the presence of other symptoms

• Patient with a negative CT and mild isolated Traumatic Brain Injury are
  – At minimal risk to develop intercranial lesion
  – Can safely be discharged
Observation to Imaging

• Level A

• Loss of consciousness or post traumatic amnesia with one or more of the following:
  – Headache
  – Vomiting
  – Age > 60 years
  – Drug or alcohol intoxication
  – Deficit in short term memory
  – Post traumatic seizure
  – Physical evidence of trauma above the clavicle
  – Focal neurological deficit
  – Glasgow Coma Scale < 15
  – Coagulopathy
Observation to Imaging

• Level B

• Head trauma with no LOC or post traumatic amnesia with one or more of the following:
  – Focal neurological deficit
  – Vomiting
  – Severe headache
  – Age > 65 years
  – Physical signs of basilar skull fracture
  – Glasgow coma scale, 15
  – Coagulopathy
  – Dangerous mechanism of injury (dangerous mechanism of injury includes ejection from motor vehicle accident, a pedestrian struck, fall from greater than 3-5 feet)
Observation to Imaging

- Level C
- NOT Specified
Emergency or Office Evaluation

• Neurological
• Cognitive
• Balance

• Any neurological deterioration or continuing focal neurological deficit should prompt further evaluation and attention
  — Admission for observation should be considered
Monitoring

• Evaluation of neurologic status with attention to the 4 categories of function

• Monitor for any changes or worsening of symptoms using a systematic and consistent tool

• Recognition for conservative return for medical attention

• Understanding of non participation and need to rest
  – 7-10 days
  – Time being a guideline - criteria is return to pre-injury function
Sports Evaluation

• On field exam-
  – Side line evaluation- 30 minutes post injury
  – Include discussion of previous concussion / head injuries
  – Compare to pre game evaluation SCAT 2-( Sports Concussion Assessment Tool) and other testing)

• Removal from play
  – ABSOLUTELY NO SAME DAY RETURN TO PLAY

• Return to activity
  – Based on patient symptoms not a time frame

• Return to School

• Return to Play

CDC guidelines(2010)
Post Injury Follow - Up

- All concussion patients should be followed by PCP (primary care physician) or licensed care provider in the 7-10 day window

- Referral for evaluation by provider proficient in neurocognitive testing
Concussion treatment varies widely among different physicians

Often times management is not based on scientific evidence or even expert consensus
Education and Preparation

• Prevention is the key
• Age appropriate protective gear
• Use of seatbelts, child restraints
• Helmets
• Parent and coach (sports) education and training
  – Pre-existing concussion protocols
  – Game day protocols for managing concussion and other head injury
• Practice recommendations are presented for pre-participation counseling, management of suspected concussion, and management of diagnosed concussion
• Implementation of policies consistent with NIH (National Institute Of Health) guidelines
Prevention and Education

• Education for family / patient
  – Monitor the 4 categories of function
  – Educated when to seek further medical care
  – Educated on the risk of second impact and cumulative injury

• Absolutely no same day play or work post injury
  – On ANY participant with suspected concussion or head injury

• Return is a gradual process based on function
  – Patient should be free of symptoms
  – If symptoms return activity needs to be decreased
  – Return to work and school may require shortened days initially
Prevention Goals

• Identification and education

• It’s important to educate others about ways to prevent concussion before it happens

• Implementing sideline evaluations & treatment recommendations
  — Recognize and treat post concussion syndrome
  — Prevent second impact syndrome
  — Prevent further morbidity
  — Prevent fatal injury
Prevention Tools

• Rule changes
  – Play smart, keep the head safe by making penalties tougher
• Use helmets and other protective equipment
• Design changes for protective equipment
• Ongoing research
  – Education, risk factors, early detection of concussion using SAC (standard assessment criteria)
No child or adolescent should return to play on the same day as the day of concussion

“When in doubt, sit them out.”
Second Impact Syndrome

- First head injury, such as headache, visual, motor or sensory changes or mental difficulty, especially with the thought and memory process
  - Greatest in the first 30 minutes post injury
  - Hypoglycolytic phase

- Before these symptoms have cleared, which may take minutes, hours, days or weeks, the athlete returns to competition

- Receives a second blow to the head

- Can cause massive swelling in the brain
Second Impact Syndrome

• Rare
  – But usually fatal

• Player gets up
  – Dazed may return to play and then suddenly drop

• Highest at risk young athletes eager to return to play

• Significant impact on coaches, healthcare and team mates
  – Studies suggest teammates may be highest risk for guilt
Sub Acute Return to Play Progression

• Baseline (Step 0)
  – As the baseline step of the Return to Play Progression, the athlete needs to have completed physical and cognitive rest and not be experiencing concussion symptoms for a minimum of 24 hours
  – Keep in mind, the younger the athlete, the more conservative the treatment

• Step 1: Light Aerobic Exercise
  – The Goal: Only to increase an athlete’s heart rate
  – The Time: 5 to 10 minutes
  – The Activities: Exercise bike, walking, or light jogging
    Absolutely no weight lifting, jumping or hard running

• Step 2: Moderate Exercise
  – The Goal: Limited body and head movement
  – The Time: Reduced from typical routine
  – The Activities: Moderate jogging, brief running, moderate-intensity stationary biking, and moderate-intensity weightlifting

• Step 3: Non-contact Exercise
  – The Goal: More intense but non-contact
  – The Time: Close to typical routine
  – The Activities: Running, high-intensity stationary biking, player’s regular weightlifting routine, non-contact sport-specific drills
    – May add some cognitive component to practice in addition to aerobic and movement components introduced in Steps 1 and 2

• Step 4: Practice
  – The Goal: Reintegrate in full contact practice

• Step 5: Play
  – The Goal: Return to competition

CDC guidelines(2010)
Graded Return to Play

- Game Play
- Full practice
- Non-contact practice
- Sport specific aerobic exercise
- Light non-sport related aerobic activity
- No activity, complete rest

- If any PCS (post concussion symptoms) should re-occur, the athlete should drop back to the previous asymptomatic level and try to progress again after 24+ hours

Types of Concussion

• Simple concussion
  – Symptoms gradually resolve
  – Patient returns to normal function in seven to 10 days

• Complex concussion
  – Symptoms persist and thought processes are affected
  – Patients with repeated concussions fall into complex category
Single vs. Multiple Injuries

• Current research
  – Supports that repeat head injury has cumulative effect

• Particularly at risk
  – Very young whose brains are still developing

• Severity of injuries and time between injury
  – Correlates with symptoms
Presentation for Repetitive Injury

• Each injury may have a slowed recovery time

• Symptoms may appear disproportionate to mechanism of most recent injury

• Closer together the injury
  – Particularly younger patients – increase risk
  – Subsequent injuries now recommend additional time between injury and return to play
Management

• Initial Concussion
  – NO same day play
  – May return when pre injury function has returned
  – Usually 7-10 days and cleared by LHP

• Second Concussion
  – Extended period without play recommend - up to one month
  – Criteria to return
    – Pre-injury function without return of symptoms with activity and cleared by LHP
    – Current discussion is to retire from play with 2

• Third Concussion
  – Recommendation is retire from play
  – Should not return current season
Post Concussion Syndrome

• Broader definition of PCS (post concussion syndrome) is represented by clinical criteria of the World Health Organization’s International Classification of Diseases

• Three or more of the following symptoms
  – Headache, dizziness, fatigue, irritability, insomnia, concentration difficulty, or memory difficulty

• These criteria are 6 times more sensitive for identifying patients with PCS (post concussion syndrome)

• After 3 weeks, patients (especially athletes) begin to worry about when they will recover

• By 6 weeks, if symptoms persist, PCS can alter their lives
Post Concussion Syndrome and Symptoms

- Headaches
- Dizziness
- Fatigue
- Irritability
- Anxiety
- Insomnia
- Loss of concentration and memory
- Noise and light sensitivity

- Usually occur 1st ten days and go away within three months
Sub Acute and Chronic Management

• Ongoing clinical symptoms, concussion history, and younger age identify those at risk for post-concussion impairments

• Risk factors for recurrent concussion include history of multiple concussions
  — Particularly within 10 days after initial concussion

• Risk factors for chronic neurobehavioral impairment
  — Include concussion exposure and APOE ε4 genotype
  — Linked to increased risk of Alzheimer’s
Long-Term Complications of TBI

- Postural Orthostatic Tachycardia Syndrome
- Post-Traumatic Encephalopathy
- Other neurologic complications
POTS-Postural Orthostatic Tachycardia Syndrome

• One of a group of disorders
  – Orthostatic intolerance (OI) as primary symptom

• Lightheadedness / faint

• Elevation of heart rate

• Unsure of exact mechanism
  – Peripheral denervation (neuropathic POTS)
  – Due to sustained or paroxysmal over activity of the sympathetic nervous system (hyperadrenergic POTS)
  – Deconditioning

NIH (2011)
PTE - Post-traumatic Encephalopathy

• Stages of post-traumatic encephalopathy

• Post traumatic coma
  – Absence of arousal

• Post traumatic delirium
  – Decreased awareness

• Post traumatic amnesia
  – Decreased new/post recall

• Post traumatic dysexecutive syndrome
  – Impaired executive function (motor, concept, attention span)

• Recovery
  – Return to baseline function

Dialogs in Neuro Science (2011)
Other Complications

• Facial injury with paralysis or numbness

• Neuropsychological effects

• Alzheimer’s disease - the connections between brain cells and the brain cells themselves degenerate and die

• Parkinson’s disease - progressive loss of motor function due to the degeneration of neurons in the area of the brain that controls movement

• Additional psychological concerns
  – Dementia pugilistica - A syndrome affecting boxers that is caused by cumulative cerebral injuries and is characterized by impaired cognitive processes and slowed, poorly coordinated movements especially of the legs
  – Depression, dementia

(NFL Players Study (2006))
Rehabilitation in TBI

• Differential diagnosis
  – Consider migraine or depression

• Post Traumatic Brain Injury
  – Occurs on a continuum

• Categorized
  – Mild
  – Moderate
  – Severe
    – Coma, vegetative state, locked in syndrome
    – Locked-in syndrome (LIS)
      – Condition in which a patient is aware and awake but cannot move or communicate verbally due to complete paralysis of nearly all voluntary muscles in the body except for the eyes.
Rehabilitation

• Moderately to severely injured patients
  – Rehabilitation involves individually tailored treatment programs
  – Physical therapy
  – Occupational therapy
  – Speech/language therapy
  – PMR-Physical medicine and rehabilitation (PM&R), or physiatry (branch of medicine which aims to enhance and restore functional ability and quality of life to those with physical impairments or disabilities)
  – Psychology/psychiatry
  – Nutrition
  – Social support

• Mildly injured patients
  – Rest and observation- reevaluation
Rehabilitation

• Physiatrist
  – Physician specializing in physical medicine and rehabilitation

• Neuropsychologist
  – Licensed psychologist with expertise in how behavior and skills are related to brain structures and systems
  – Assesses speaking challenges
  – Communication dysfunction
  – Being overly impulsive
  – Making poor decisions
  – Difficulty concentrating
  – Loss of memory
Rehabilitation

• Rehabilitation nurse
  – Helps patients achieve improved health and adapt to a changed lifestyle post-injury
  – Nutrition
  – Pain
  – Sleeping disruption
  – Mobility
  – Bladder and bowel incontinence
  – Self care
  – Communication, comprehension, and cognition
Rehabilitation

• Physical Therapist
  – Deals in musculoskeletal problems
  – Including knee injuries, low back pain or other pain areas
  – TBI (traumatic brain injury) rehab goal is to lessen as well as surmount any possible paralyzing effects due to the brain injury
  – Posture
  – Strength
  – Balance
  – Degree and quality of movement
  – Coordination
  – Pain management
  – Need for support such as cane, brace, or wheelchair
Rehabilitation

• Occupational Therapist
  – Determines function and possible problems connected with daily living skills, vision, perception, cognition, and upper extremity movement
  – Works with the brain injury patient to adapt to typical lifestyle functions like dressing and showering
  – Grocery shopping
  – Cooking
  – Banking
  – Personal hygiene
  – Returning to work
Rehabilitation

• Small body of evidence supporting rehabilitation focus on tasks and activity not solely on cognitive function

• Needs to be multidisciplinary

• Guidelines are to progress based on individual tolerance and to decrease progression with reoccurrence of concussion symptoms
Considerations for All Groups

• Violence - chances for repeat abuse

• Populations at risk
  – Elders
  – Prisoners
  – Children
  – Adolescents (consider relationships)
  – Adolescents involved in sports are at higher risk for repeat injury
Significance of Early Detection Management

• Impact on quality of life
  – Adolescent education- career choices/options
  – Adult career and work function
  – Depression related to disability / cognitive/ somatic

• Impact to family and relationships

• TBI (traumatic brain injury) related costs
  – Potential to lower direct medical costs and indirect costs such as lost productivity
References and Guidelines

• Centers for Disease Control and Prevention 2012
  – How many people have TBI?
  – Retrieved June 12, 2012 from

• American Academy of Family Physicians 2010
  – Traumatic brain injury: Overview
  – Retrieved May 24, 2012 from

• Centers for Disease Control and Prevention 2011
  – Concussion and mild TBI. Retrieved May 24, 2012 from

• Centers for Disease Control and Prevention 2010
  – Concussion: Feeling better. Retrieved May 24, 2012 from
    – www.cdc.gov/concussion/feel_better.html

• National Institute of Neurological Disorders and Stroke 2012
  – Stroke information page. Retrieved June 14, 2012 from

• National Institute of Neurological Disorders and Stroke 2011
Guidelines

• www.cdc.gov/concussion/HeadsUp/clinicians_guide.html

• www.acep.org/clinicalpolicies/
  — Summary of evidence-based guideline update: evaluation and management of concussion in sports: Report of the
  Guideline Development Subcommittee of the American Academy of Neurology.
  — Neurology 2013 11;80: 2250-7

• Jagod A.S., Bazarlan, J., et.al. (2008).
  — Clinical Policy: Neuroimaging and Decision making in Adult Mild Traumatic Brain Injury in the Acute Setting

  — Return to Play Guidelines Can not solve the football - related Concussion Problem.

• Kanjwal, K,, Karabin ,B , Kanjwal, Y.& Grubb, BP, (2010)
  — Autonomic dysfunction presenting as postural tachycardia syndrome following traumatic brain injury.
  — Journal of Cardiology. 2010;17; 482-7.

• Leddy, J.L, Sandhu,H et al (21012)
  — Rehabilitation of Concussion and Post Concussion Syndrome.

  — Understanding Athletic Trainers’ Beliefs Toward a Multi-faceted Sports-Related Concussion Approach; Application of the
    Theory of Planned Behavior

  — Concussion.

  — Effect of Psychological Interventions on Depressive Symptoms in Long –Term Rehabilitation After an Acquired Brain
    Injury: A Systematic Review and Meta-Analysis.
  — Archives of Physical Medicine and Rehabilitation. 2013; 94;1386-97
Cleveland Clinic

Every life deserves world class care.