Pre-Participation Screening and Sideline Management of Neurologic Problems in Athletes

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Disclosures

• No commercial or research relationships with any of the products or services discussed today
• This presentation included slides and data from Dr. Warne Fitch’s presentation “Head Injury in Sports” from the 2009 Vanderbilt Sports Medicine lecture series and also from the 2010 NFL Head Injury Symposium at Johns Hopkins Medical Center

Overview

• Scope of the problem
• Game site management - Preparation, triage, and record keeping
• Pre-participation screening
• Seizures
• Scalp lacerations
• Intracranial hematomas
• Major traumatic brain injury (TBI)
• Mild TBI (concussion)
  – Diagnosis/assessment, pathophysiology, classification, natural history, imaging
  – Treatment, RTP, long term effects, prevention
**Historical Note**

- In 1905, there were 18 deaths and 159 documented serious injuries attributed to the game of football.
- In response, President Theodore Roosevelt convened representatives from academic institutions and formed a committee to revise the rules of the game.

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**Teddy and the NCAA**

- The initial meeting expanded to a group of 13 academic institutions, and in 1906 the group was chartered as the Intercollegiate Athletic Association of the United States (IAAUS).
- In 1910, the name was changed to the National Collegiate Athletic Association (NCAA).

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**Pre-participation screening for neurologic conditions**
Neurologic history
- Major brain or spine injury
- Concussions
  - Number, dates, estimate of severity (games and practices missed, schoolwork effects, etc.)
- Seizure
  - Include febrile seizures
- Headaches – migraine, cluster, etc.
- Psychiatric conditions/medications
- Learning disabilities – ADHD (meds), special classes, grades repeated
- Hydrocephalus or shunt device
- Family history of neurologic illness
  - Especially headache, epilepsy, spine dz

Disqualification for intracranial conditions

Classification of sports by likelihood of concussion
- Collision sports
- Contact sports
- Limited contact sports
- Non-contact sports
“Football is not a contact sport – it’s a collision sport. Dancing is a contact sport.”

- Vince Lombardi

Collision sports
- Boxing
- Football
- Ice hockey
- Rodeo
- Rugby

Contact sports
- Basketball
- Diving
- Field hockey
- Lacrosse
- Martial arts
- Soccer
- Wrestling
Limited contact sports

- Baseball
- Bicycling
- Cheerleading
- Field events
  - High jump
  - Pole vault
- Gymnastics
- Horseback riding
- Skating (ice, inline, roller)
- Skiing and Snowboarding
- Softball
- Surfing
- Ultimate frisbee
- Volleyball

Disqualification - Intracranial conditions

Should NOT automatically disqualify for:
- Previous craniotomy (LOE 4)
- Arachnoid cyst or congenital malformations such as cavum septum pellucidum (LOE 5)
- Shunt or hydrocephalus (LOE 5)
  - Neurosurgery 54:1190–1198, 2004
  - Survey of US pediatric neurosurgeons found < 1% incidence of sports-related shunt problems
  - Benign brain tumor

Intracranial conditions

Seizure disorder
- VERY complex issue
- Depends upon the type of seizure, current seizure control and the requested sport
  - Generalized, simple partial, complex partial
  - “elevated” sports – gymnastics, horse events
  - Water sports
- Contact sports do NOT worsen epilepsy and exercise may have a slightly protective effect
  - Howard GM, Radloff M, Sevier TL: Epilepsy and sports participation.
- Medication compliance and drug levels
  - Phenytoin– poor choice
- Avoid dehydration
Intracranial conditions

- CAUTION in contact sports for
  - Malignant tumor
  - Vascular malformation
  - History of spontaneous subarachnoid hemorrhage
  - History of parenchymal contusion
- Collision sports not recommended for above

- NOTE: ALL of these decisions should consider the type of sport, level of play, and the unique features of the lesion

Neurosurg Focus 21 (4):E9, 2006

Game site management

- Specialist availability
  - Who would handle a neurological emergency, and what is their availability?
  - Timely transport and triage for definitive neurological critical care for severe injuries
- Staff assessment / decision making
  - “chain of command” – who makes the final decision on site about RTP
  - All training and physician staff alert for neurological symptoms – not always as obvious as musculoskeletal injuries
**Game site management - supplies**
- Airway equipment
- IV access
- Anti-seizure medications
- Surgical stapler
- Cervical collar (rigid if spine board not available)
- *Don't need iced saline!!!*

**Game site situations**
- Importance of record keeping during the event
  - Ex. – multiple stingers, concussion with short duration of symptoms
- Post-event surveillance
  - Many neuro injuries will evolve over the next 72 hours
  - Don’t allow concussed player to be alone for first 24 hours (esp. college)
  - After hours contact info for training or physician staff

**Game site – head injuries that “need a ride”**
When to transport to neuro critical care center

- Immediate evaluation for signs of more serious injury
  - Concussion + spinal cord symptoms
  - LOC > 1 minute
  - Seizure in patient with no previous history
  - Deep scalp laceration with significant blood loss
  - Persistent drowsiness
  - Headache that is getting much worse, especially with vomiting
  - Severe neck pain
  - Trouble moving arms or legs
  - Any lateralizing neurological sign – motor or pupil asymmetry, hemisensory loss, etc.

Medical evaluation for more serious injuries

- Delayed evaluation:
  - Symptoms lasting more than a few days
  - Symptoms worse each day
  - Second episode during same season
  - Incapacitating symptoms of headache, nausea, dizziness, etc.
  - Persistent significant problems with concentration and memory
Emergency Management of seizures

Seizures and epilepsy

- Seizure = abnormal electrical discharge from neurons resulting in a change in neurological function
- Epilepsy = a disorder of brain function characterized by the occurrence of periodic or unpredictable seizures
  - Aka “seizure disorder”
  - Affects 2.5 million Americans of all ages
  - 181,000 new cases of seizures per year
  - Annual cost = $12.5 billion
- Epilepsy may be congenital or due to trauma, tumor, stroke, infection, or metabolic problems
  - 50% of cases have no identifiable cause

Seizure types

- Generalized seizures
- Partial seizures
Generalized seizures

- Consciousness is impaired
- Both brain hemispheres involved from the start
- Types:
  - Absence
  - Myoclonic
  - Tonic-clonic
  - Atonic

Absence seizures:
- Brief disruption of consciousness
  - Seconds to a minute
  - Staring spells
  - Formerly called “petit mal”

Myoclonic seizures:
- Sudden muscle jerks, one or more limbs

Tonic-clonic seizures:
- Tonic phase – stiffening, cry out, incontinence
- Clonic phase – repeated jerking
- Post-ictal phase – fatigue and limpness

Atonic seizure ("drop attack"):  
- Sudden loss of muscle tone
Partial seizures
• Electrical disturbance starts in one hemisphere only
  – May spread to the other
    • “Secondary generalization”
    • This can lead to loss of consciousness
• May be simple partial or complex partial

Simple partial seizures
• Patient is still conscious
• Symptoms depend on involved brain region:
  – Focal motor movements, tingling, speech arrest, flashing lights, unusual smell/taste/sound, autonomic symptoms, “déjà vu” feelings

Complex partial seizures
• Same sx as simple partial, but may also have altered LOC with automatisms (chewing movements, picking at clothes, etc.)
Sideline seizure management

• Most seizures are self limited and will stop in 60 seconds or less
• Protect the head, watch for fall
• Turn head to side to prevent aspiration
  – Vomiting is common, even after seizure stops
  – Hypoxia is common during the seizure
• Note duration of seizure
• Obtain patient’s medical history of seizure

Sideline seizure management

• DO NOT:
  – Attempt to restrain the patient
  – Place anything into the mouth

Sideline seizure management

• If seizure is continuing after 5 minutes, need to consider immediate transport and pharmacologic therapy
  – If EMS is available, they should have meds and IV access
  – If not, several options:
    • IM – Versed 10 mg (LOE 4)
    • IM – Fosphenytoin 1.5 gram
    • IV – Ativan 2 mg, may repeat x 1
Sideline seizure management

• No RTP in same game for first seizure, any generalized seizure, or any simple partial seizure lasting more than 30 seconds.
• Consider hypoglycemia in causative role, especially if pt is diabetic
  – If can’t check glucose can give D50 or other glucose source

Scalp lacerations

“Rollin’ with the Tide”
Scalp lacerations

- Significant potential for large blood loss
- Not a reliable predictor of underlying skull fracture
- Direct pressure
- Keep degloved flaps approximated
- Temporize with staples in skin even if delayed closure will be needed
  - Multi-layer closure should be done in hospital
  - Antibiotics if significant delay expected

Skull fractures and hematomas

Skull anatomy

- Varying thickness
- Thinnest in temporal and sub-occipital areas
- Frequently harbors large venous channels
- Closely approximated to underlying dura
Skull fractures – diagnosis and management

- CANNOT reliably diagnose these lesions by palpation
  - Significant individual variability in baseline contours of skull
- Does not always have an associated scalp laceration
- May occur even with mild brain injury
- If suspected – refer for CT
  - X-ray useless

Basilar skull fracture

- Often presents in delayed fashion
- Signs and symptoms depend upon location
- Symptoms:
  - Hearing loss, severe dysequilibrium
  - CSF rhinorrhea or otorrhea
  - Loss of smell or taste
- Signs:
  - "raccoon eyes"
  - Battle sign (bruising over mastoid)
Intracranial hematomas in sports

- Suspected from symptoms and course:
  - Severe headache with vomiting
  - Lethargy
  - Pupil asymmetry (with above)
  - Lateralizing neuro signs
  - Beware the “lucid interval”
    - Initial mild symptoms, then rapid deterioration
    - Usually occurs within 6 hours


Major traumatic brain injury

- REMEMBER: in the unconscious patient ALWAYS assume an associated spine injury
- ABC's
  - Emergency airway
  - Hyperventilation
  - If LE function confirmed, ELEVATE head 30 degrees to reduce ICP


Game site – spine injuries
Game site - spine

- Stinger vs. spinal cord injury
  - Stinger will always be in the distribution of a single nerve root
  - Stingers will usually not have significant neck pain
  - Sensory sx usually > motor loss in stinger
  - *Any bilateral upper limb symptom, or any lower limb symptom suggests spinal cord injury*
  - Bilateral “burning hands” also suggests spinal cord injury

Game site – spine (continued)

- Recurrent stingers
  - Return to play only when sx of first stinger are resolved
  - 2nd stinger after previous return to normal – watch length and completeness of recovery period
  - Evaluation if symptoms do not completely resolve by end of contest
  - Stingers in several different dermatomes during same contest raise possibility of brachial plexus or spinal cord origin

Game site – spine (continued)

- Occult fx and dislocations
  - Usually complain of severe neck pain, often with associated intrascapular pain or burning
  - May not have other motor or sensory symptoms
  - Keep high index of suspicion
Sideline assessment

• Tools
  – Sideline Assessment of Concussion (SAC)
  – Maddock’s questions
  – McGill ACE
  – ImPACT sideline evaluation card
  – Sport Concussion Assessment Tool (SCAT2)

Brief assessment tools do not allow an exhaustive evaluation of all cognitive domains (eg, reaction time, information processing speed) sensitive to change after concussion. Screening instruments also do not represent a stand-alone method for declaring full recovery or clearing an athlete to return to play after concussion. All clinical information should be considered to ensure that a player is completely symptom free for a period before being released to return to competition after experiencing a head injury of any severity.

• Sideline evaluation of cognitive function is an essential component in the assessment of this injury. Brief neuropsychological test batteries that assess attention and memory function have been shown to be practical and effective. Such tests include the Maddocks questions and the Standardized Assessment of Concussion (SAC). It is worth noting that standard orientation questions (eg, time, place, person) have been shown to be unreliable in the sporting situation when compared with memory assessment. It is recognized, however, that abbreviated testing paradigms are designed for rapid concussion screening on the sidelines and are not meant to replace comprehensive neuropsychological testing which is sensitive to detect subtle deficits that may exist beyond the acute episode nor should they be used as a stand-alone tool for the ongoing management of sports concussions.

No studies in the literature have assessed the reliability, validity, or predictive value of these tools in the sideline management of sports-related concussions.
Sideline eval – what to do?

- Brief systematic inquiry of symptoms to include headache, dizziness or lightheadedness, nausea, “fogginess”
- Brief focused neuro exam
  - Pupils, EOMs, pronator drift, single leg balance or tandem walk
- ImPACT sideline assessment testing

On Field Cognitive Testing

Orientation: Questions to ask the athlete
- What stadium is this?
- What city is this?
- Who is the opposing team?
- What month is it?
- What day is it?

Anterograde Amnesia: Ask the athlete to repeat the words
- Girl, Dog, Green

Retrograde Amnesia: Questions to ask the athlete
- What happened in the prior quarter/period?
- What was the score of the game prior to the hit?
- Do you remember the hit?

Concentration: Ask the athlete the following
- Repeat the days of the week backwards (starting with today)
- Repeat these numbers backwards: -63 (36 is correct) 419 (914 is correct)

Word list memory: Ask the athlete to repeat the three words from before:
- Girl, Dog, Green

*Any failure should be considered abnormal. Consult a physician following a suspected concussion.

Concussion grading scales

"Looks like a grade 3 to me"
Cantu Concussion Grading Scale

*Most often cited grading and return to play guideline

Published evidence supporting concussion grading scales - through 8/11
Concussion grading scales

• Each of these guidelines has attempted to classify severity of concussions based on presenting symptoms (grade 1, 2, and 3)
  – No standardized definitions
  – No correlation with outcome
  – Arbitrary return to play guidelines
  – Becoming obsolete

Concussion classification – modern thoughts

• Each concussion is assessed independently based upon:
  – Nature and duration of symptoms and signs
  – Player’s age
  – Player’s previous concussion history

Concussion natural history studies

“This is not going to end well.”
Natural History Studies

High School
1. Powell et al. *JAMA*. 1999

College

NFL

High school data
Guskiewicz, et al AJSM, 2000—Level 4
- Surveyed 242 ATC’s over 3 years (62% response)
- Used Cantu's grading system 1, 2, 3
  - Grade I—89%, grade 2—10%, grade 3—0.5%
  - 5.6% of HS football players with concussion
  - 17% sustained multiple concussions
  - 4.4% of NCAA DI football players with concussion
  - 9.8% sustained multiple concussions
  - Players with one concussion, 3 times more likely to sustain additional concussion in same season

High school data
Guskiewicz: Signs and Symptoms
- Headache—86%
- Dizziness—67%
- Confusion—59%
- Amnesia—27%
- LOC—8.9%
**High school data**
Powell et al. JAMA. 1999 — Level 2

- Prospective observational cohort (NATA Injury Surveillance database)
  - 246 trainers at 114 high schools recorded data for 3 years
- Concussion defined as:
  - Head injured player who was removed from participation and evaluated by athletic trainer or physician prior to return of play
- Football with highest injury rate (63%)
  - Per 1000 athlete exposures
    - Football 0.59
    - Boys’ soccer 0.18
    - Girls’ soccer 0.23
    - Wrestling 0.25
  - Football—11 times higher in games than practices
  - 693 injuries—4 SDH, 2 intracranial hematomas football only

**Management:**
- 89% removed from session
- Median time lost (all sports) — 3 days

**72 Repeat Concussions**
- 47 had 2nd in same season
- 14 had 2nd following season
  - One had 3 concussions in 1 season, 1 had 4.

**College data**

- Prospective Cohort— Level 2
  - 2905 college FB players, 25 colleges over 3 years
- Incidence: 0.81 per 1000 athlete exposure
- 196 concussions
- 12 repeat concussions (6.1%)
- 3 x greater risk during games
College data
Guskiewicz et al. JAMA 2003—Level 2

- Presentation
  - Headache 85%
  - Dizziness 77%
  - Amnesia 24%
  - LOC 6%
- Ave duration 3.5 days
- 88% full recovery at 1 week

NFL data

- Prospective Cohort—Level 2
  - 1996-2001 recorded concussions in NFL
  - Broad definition:
    - "Traumatically induced alteration in brain function"
  - Standardized reporting form
  - 787 cases in 1913 games
  - Incidence 131.2+/−26.8 concussions/year
  - Rate of 0.41 concussion/game

NFL data
Powell et al. Neurosurg 54(1) 2004.—Level 2

- Three most common symptoms:
  1. Headaches (55%)
  2. Dizziness (42%)
  3. Blurred vision (16.3)
- 45.9% experienced either cognitive or memory problems
- 9.3% had LOC
Level 2 - prospective cohort study
From the Johns Hopkins NFL 2010 concussion conference

Pellman et al, Neurosurgery 54: 81-96, 2004

Selected risk estimates

- Quarterback 1.62 (1.22-2.02)
- Wide receiver 1.23 (0.95-1.61)
- Tight end 0.94 (0.63-1.35)
- Running back 0.99 (0.89-1.11)
- Defensive line 0.29 (0.21-0.37)
- Defensive sec. 0.93 (0.78-1.08)
- Defensive lbir 0.45 (0.33-0.57)
- Offensive line 0.44 (0.34-0.54)

NFL data

- 93% <7days lost
- LOC players
  - Averaged 5.0 +/- 7.5days
  - 2.6 times longer
- 56.5% no days out
Prevention strategies and equipment

Strategies for concussion prevention
• HELMETS!
• Proper equipment
• Good technique
• Maximize safety of play environments
• Age-specific guidelines for amount of contact allowed
• Avoid returning to play until previous injuries have fully healed

Helmet use
• Bicycling
• 4 wheelers
• Horse riding
• Skiing
• Snowboarding (dude)
• Sledding
• Batting or running bases in baseball and softball (base coaches)
Prevention: New Riddell Football Helmets

Riddell Revolution Helmet

- Collins et al. Neurosurg. 2006
- Prospective Cohort—Level 2
  - 2,141 HS football players in PA
  - 1,173 with Revolution, 968 standard
- Concussion significantly less in Revolution group 5.3% vs 7.6% (p=0.027)
- Small study (136 concussions), authors with financial disclosures, older helmets/younger athletes in standard group

2010 NFL/NFLPA study

- The results of an independent study commissioned by the NFL and the players’ union show modern helmets meet all national safety standards, though it stressed that no helmet can prevent concussions and more studies are necessary.
- The results showed that all 16 helmets met or exceeded national standards to protect players against traumatic head injuries, and none performed worse than a reference group of helmets from the 1990s. Three of the modern helmets—the Riddell Revolution, the Revolution Speed and the Schutt DNA Pro—were singled out as the top-performing helmets.
Prevention: Mouth Guards

- Prospective cohort—Level 2
- No difference in concussion rate
- Significantly lower rate of dental trauma

Head Gear in Soccer

  - For ball impacts, no benefit to headgear.
  - In head to head impact tests the headgear provided an overall 33% reduction in impact response.

Heading in Soccer

- Level 3 Cohort
- CONCLUSION:
  - Computerized neuropsychological testing revealed no evidence of neuropsychological impairment due to heading exposure or previous concussions in a cohort of Norwegian professional football players.
Proper equipment and technique

- “See” the target you intend to tackle
  - Don’t use head as a spear
  - Avoid helmet to helmet contact
- Move head and neck as a unit when “heading” the ball in soccer
- Neck muscle strengthening as level of play increases

Thanks!