

# Put Me Back in ~~Coach~~ (Doc)!



Management of Sports-Related Concussion

Michael S. Reardon, M.D.

Dell Children's Medical Center of Central Texas

Pediatric Conference 4/10/2010

# Concussion

## Take home points

- Repeat head trauma before full recovery from concussion can be very dangerous
- While most patients recovery completely, some may develop long-term and progressive neurological deficits, even after a single concussion.
- Previous return-to - play timetables based on grading of concussion have been replaced by individualized management based on each athletes course of recovery.
- Rest is the primary treatment for concussion.
- Once full recovery has been documented, return to play should follow a gradual, step-wise process, with return to lower level of activity if any symptoms or signs return.

# What is a Concussion?



## Definitions

“Alienation of the mind, with a privation of sense and motion” –Marchetti, 1665

“A trauma induced alteration in mental status, with or without loss of consciousness” –Kelly, JP, AAN Practice Parameter, 1997

## Implies

- absence of radiographic/structural pathology
- gradual recovery

# What is a Concussion?

- Concussion is any alteration in mental status, neurological functioning, or neurological symptoms resulting from trauma, in the absence of physical brain injury such as contusion, hemorrhage, or infarction.
- Concussion involves metabolic dysfunction of the brain that makes the brain more vulnerable to subsequent injury, and may initiate a cascade of cellular events that leads to long term symptoms and/or delayed neuro-cognitive decline, even after one or two concussions.

# What Does Concussion Look Like?



# Signs and symptoms of Concussion

- Signs observed by others
  - Appears dazed or stunned
  - Is confused about assignments
  - Forgets plays
  - Is unsure of game, score, or opponent
  - Moves clumsily
  - Answers questions slowly
  - Loses consciousness
  - Shows behavior or personality change
  - Forgets events before play
  - Forgets events after hit
- Symptoms reported by players
  - Headache
  - Nausea
  - Balance problems or dizziness
  - Double, fuzzy, or blurry vision
  - Sensitivity to light or noise
  - Feeling slowed down
  - Feeling foggy or groggy
  - Concentration or memory problems
  - Change in sleep pattern
  - Feeling fatigued

# AAN Sideline Examination

## 1) Orientation

- Time of day (w/in 1 hr)
- Day/date/location
- Circumstance/details of injury

## 2) Immediate Recall

- 3 words

## 3) Attention

- Digits Backward
  - 5 - 3 - 0 - 7 - 4
  - 7 - 2 - 5 - 9 - 3
- Months of year in reverse

## 4) Neuro Exam

- Pupils
- Eye movements
- Strength
- Sensory (light touch, Romberg)
- Coordination (finger-nose, tandem)

## 5) Delayed Recall

- previous 3 words

## 6) Exertional maneuvers

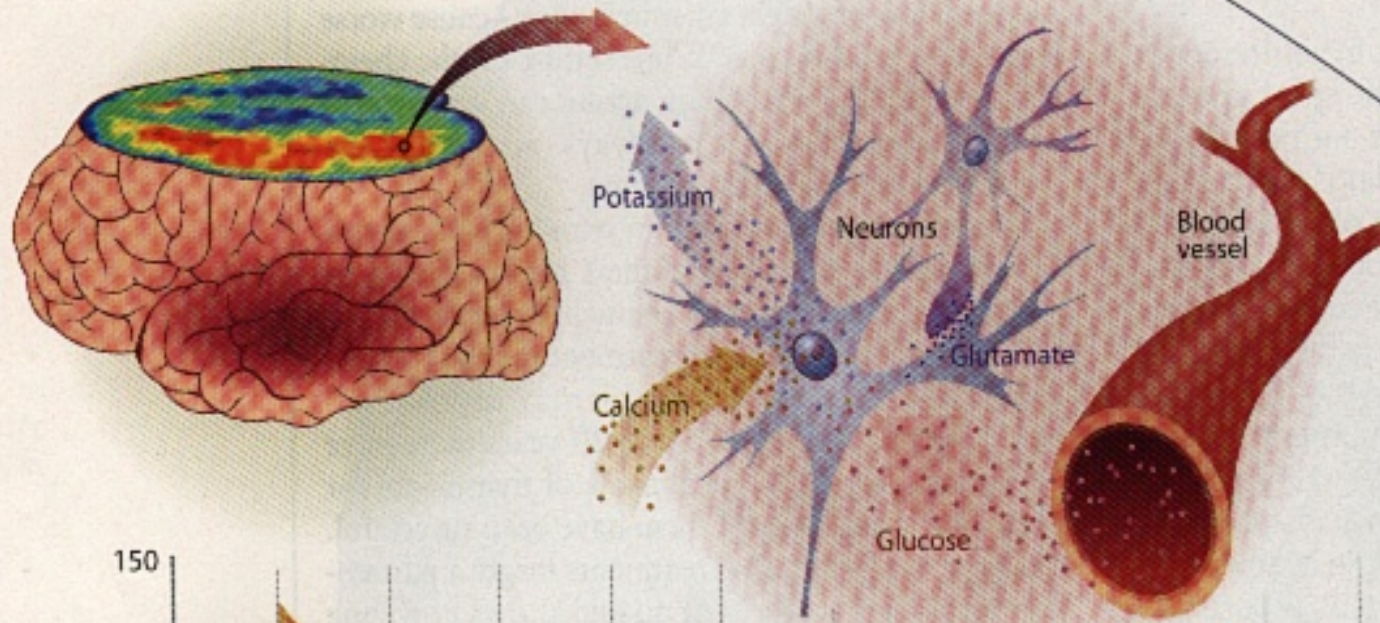
- 5 push-ups, sit-ups, and deep knee-bends
- 40 yard sprint (when feasible)

# What is a Concussion?

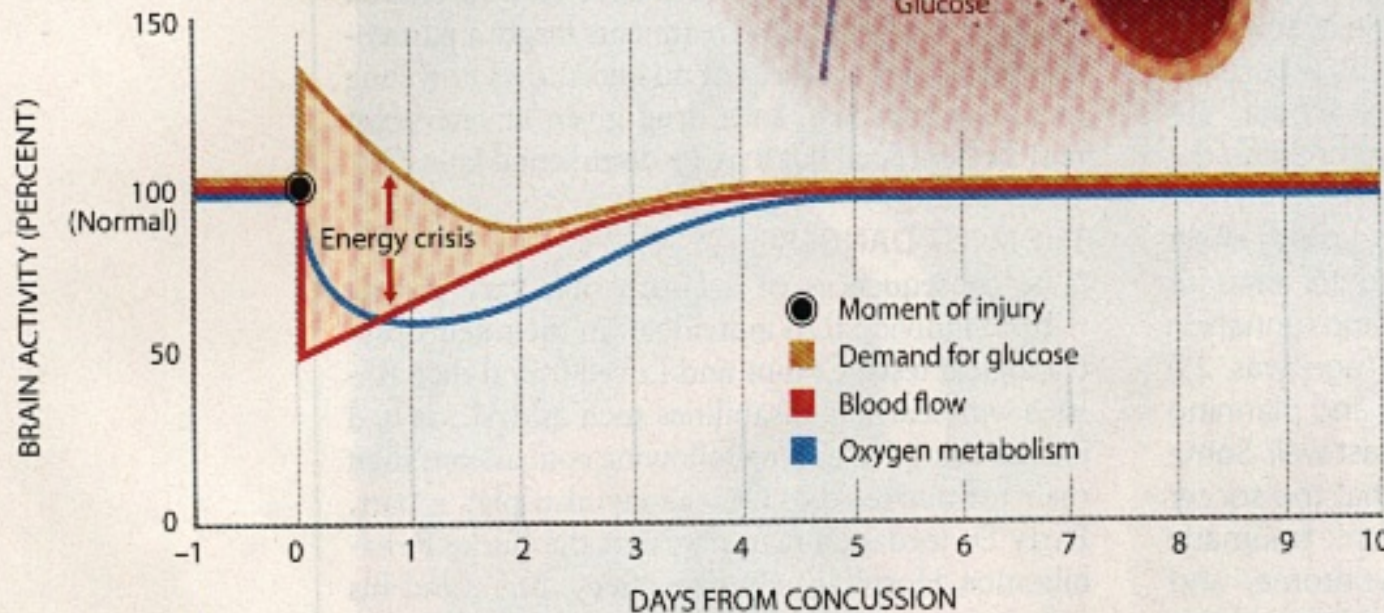
## Pathophysiology

- Rotational/Shearing forces causing mechanical perturbation of neurons
- Excessive excitatory neurotransmitter release and calcium influx
- Increased metabolic demand
- Altered glucose transport and utilization
- Altered vascular/blood-brain barrier function
- Altered blood/oxygen/nutrient delivery
- Culminating in impaired neural transmission

## Anatomy of a Concussion



A blow to the brain sets off a flood of neurotransmitters such as glutamate. This prompts neurons to fire incessantly, causing an influx of calcium into the neurons and a release of potassium. To keep firing, the neurons demand extra energy, but the excess calcium reduces oxygen metabolism and thus the cells' ability to generate it. Meanwhile the wash of potassium constricts blood vessels, limiting the supply of new glucose fuel. The high energy demand, restricted blood flow and oxygen debt create an energy crisis that exhausts the neurons, leading to the mental confusion and failed memory of concussion. The brain may take days to restore the chemical balance that constitutes full recovery.



# Potential Complications

## 1) progressive cerebral edema (severe concussion + hypotension/hypoxia)

Combination of impaired delivery and utilization can lead to vicious cycle of cytotoxic edema → increased ICP → decreased cerebral perfusion pressure → worsened cellular injury → worsened ICP, etc.

## 2) *Second Impact Syndrome*

Mild head trauma while brain is still in a metabolically vulnerable state may trigger the above catastrophic reaction.

# Potential Complications

## 3) Post-Concussive Syndrome

Even after mild to moderate concussion, some patients are known to experience symptoms and/or neuropsychological impairment for months

## 4) Mild Cognitive Impairment or Dementia

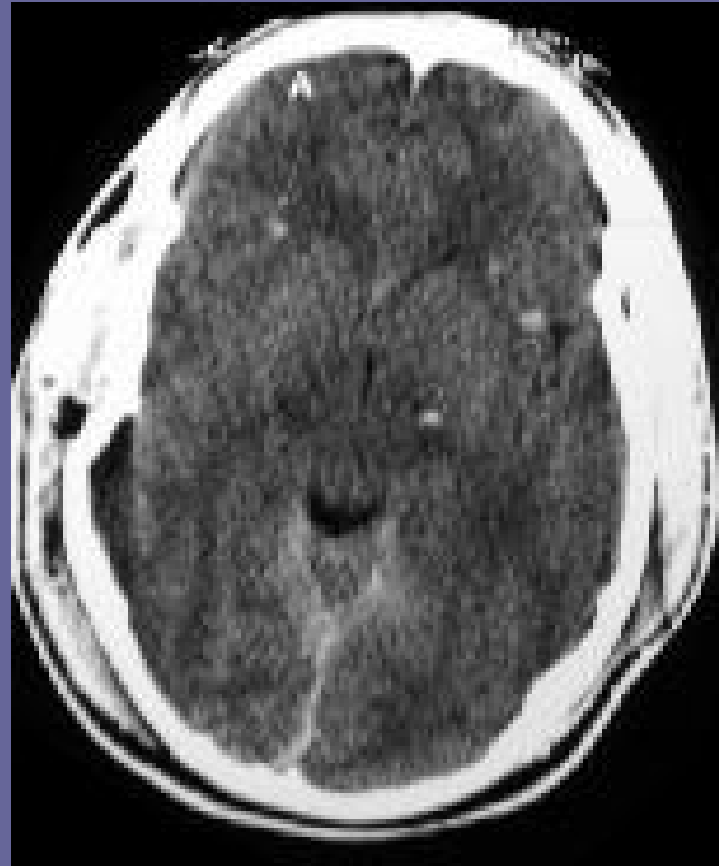
Repeated concussions have been associated with cumulative and permanent impairment, which can include progressive dementia (dementia pugilistica)

# Differential Diagnosis

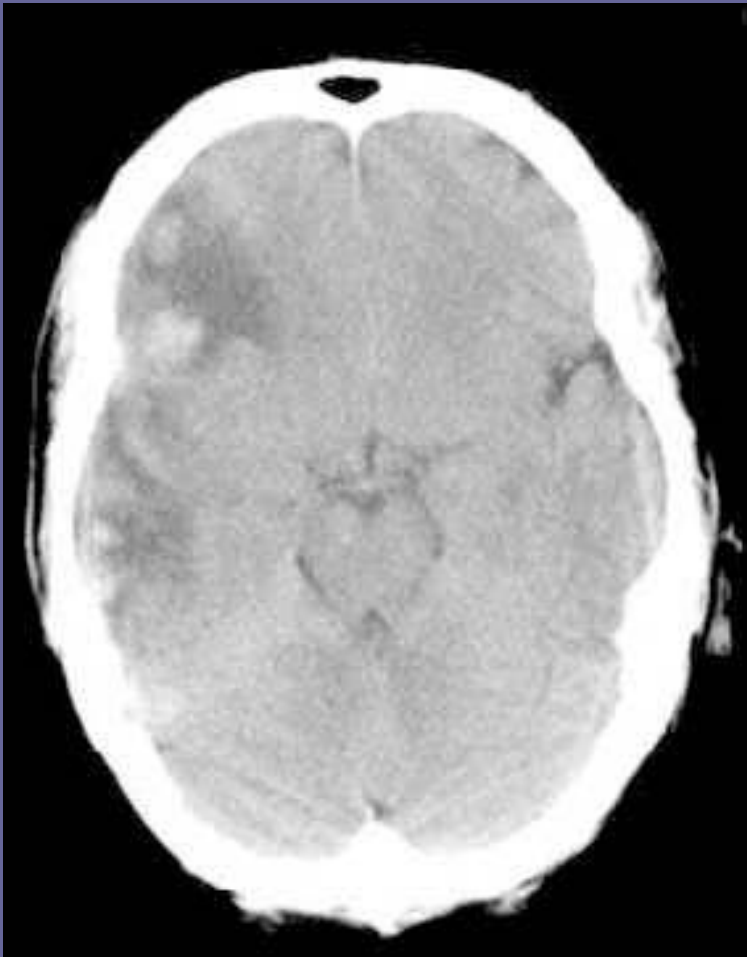
## Diffuse Axonal Injury

Persistent unconsciousness or progressively worsening level of consciousness

Petechial hemorrhage and edema



# Differential Diagnosis



## Contusion

Focal deficits

Partial onset Seizures

Intracerebral blood mixed with edema

Potential to progress to larger hematoma

# Differential Diagnosis



## Subdural Hematoma

Progressive focal deficit

Depressed level of consciousness

Seizures

# Differential Diagnosis

## Epidural Hematoma

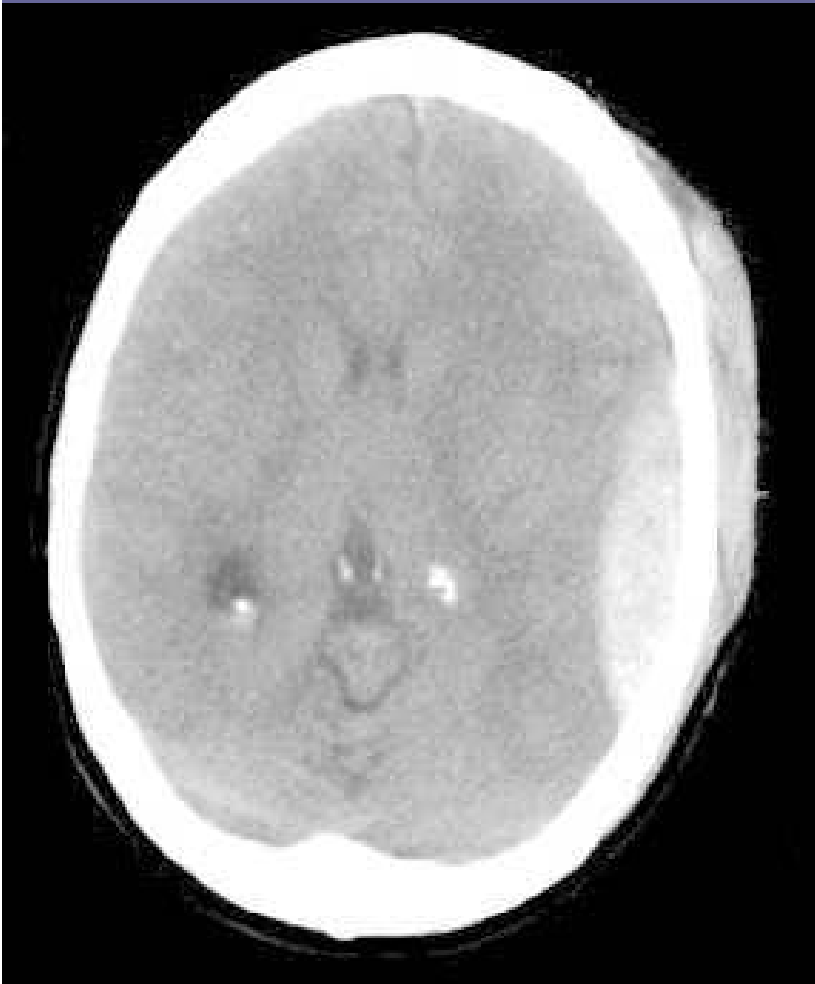
Classic “lucid interval”

Progressive focal deficit and depression of consciousness

Uncal herniation

Blood confined within suture lines

Associated with skull fracture and meningeal artery tear

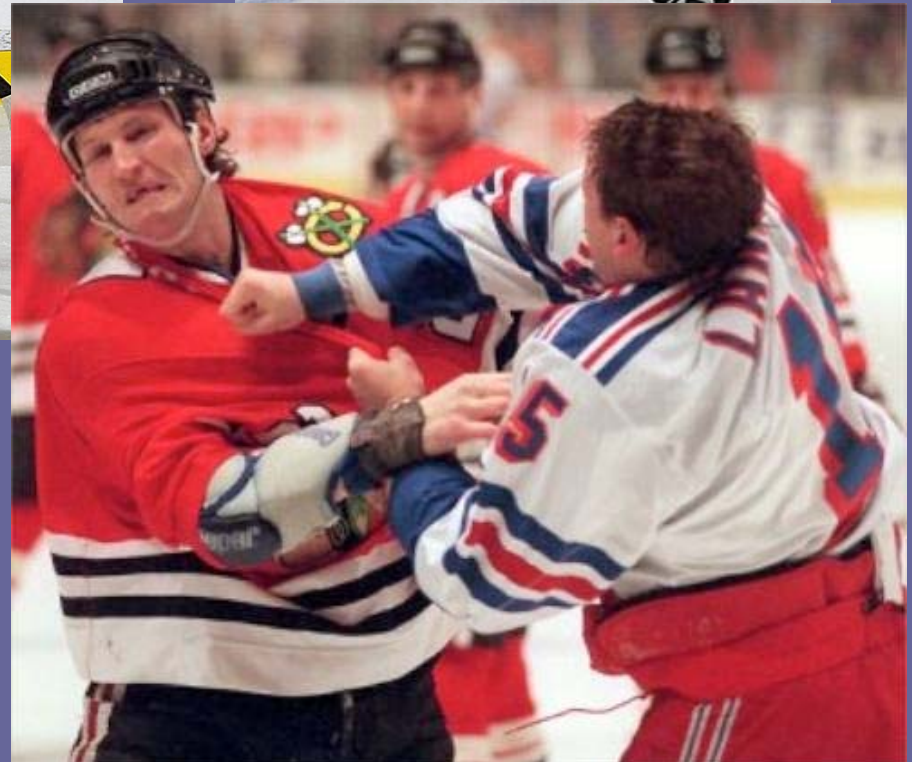


# Who is most at risk?

- The chances of concussion vary significantly by type of sport.
  - Combat Sports
  - Collision Sports
  - Contact Sports
- The rate of concussion is 25% per match in boxing, which should be banned according to the American Academy of Neurology.
- Concussion rates in football and ice hockey range from 3-6% per season.
- Soccer has limited and variable data ranging from 1 to 1.4/1000 exposures for high school to 3% per season for college.
  - Heading the soccer ball does not cause concussion or long term neurological problems.
- Concussion is rare in most other sports.
- **A person with a history of concussion is 4-6 times more likely to have subsequent concussions**



Lewis vs Rahman, 2001









# Concussion Management in the 20<sup>th</sup> Century

- Multiple systems for grading severity of concussion which dictated timeline for return to sports participation
- Guidelines often based on opinion from panels of experts with minimal scientific data
- Most emphasized loss of consciousness as a key indicator of severity
- Some allowed immediate return to play if no loss of consciousness and rapid improvement in core symptoms and signs.
- ***New research in the past decade has led to significant changes in management guidelines***

# Grading of Concussion

## Grade 1

## Grade 2

## Grade 3

**AAN**

No LOC  
Mental status changes resolve within 15 minutes

No LOC  
Mental Status changes persist beyond 15 minutes

Any LOC  
(recommendations differ for LOC < or > 1 minute)

**ACSM**

No LOC  
Amnesia < 5 min

LOC < 5 min  
Amnesia > 30 min but < 24 hr

LOC > 5 min  
Amnesia > 24 hr

**Revised Cantu**

No LOC  
Post-concussive Signs/Symptoms (PCSS) < 30 min

LOC < 1 min, **or**  
Amnesia > 30 min, < 24 hr, **or**  
PCSS > 30 min, < 7 days

LOC > 1 min, **or**  
Amnesia > 24 hr, **or**  
PCSS > 7 days

# AAN Practice Guidelines

- **Grade 1** (no LOC, PCSS resolve w/in 15 min)
  - Remove from play temporarily
  - May return to play if normal w/in 15 min
- **Second Grade 1**
  - Remove from contest
  - Return to play when free of PCSS for 1 week

# AAN Practice Guidelines

- **Grade 2** (no LOC, but PCSS last > 15 min)
  - Remove from contest
  - Reassess “frequently” for worsening
  - To hospital if worsening or if PCSS last > 1 hr
  - Re-evaluate in 24 hr
  - May return to competition if normal eval by physician for 1 week
  - MRI or CT if PCSS > 1 week
  - If any pathology, end season, and consider ending career
- **Second Grade 2**
  - Same acute management
  - May return to competition if normal per physician eval for 2 weeks

# AAN Practice Guidelines

- **Grade 3** (any LOC)
  - **LOC < 1 min**
    - Remove from contest
    - Assess frequently and manage as in grade 2
    - May return when normal per physician eval for 1 week
  - **LOC > 1 min**
    - Remove from contest and send for complete neurologic evaluation
    - If LOC not resolving, transport urgently to ER with C-spine precautions
    - May return to play if normal eval for 2 weeks
- **Second Grade 3**
  - May return to play if normal for 1 month

# New Evidence Clinical

- Loss of consciousness occurs in less than 10% of concussions.
  - LOC > 1-2 minutes is very rare.
- Presence or absence of LOC is not predictive of post-injury neuro-cognitive deficits or persistent symptoms.
- Post-injury amnesia, even for seconds, is more predictive of persistent neuro-cognitive deficits and symptoms.
- High School athletes with “ding” or “very mild concussion” have been found to require seven or more days before full symptom and neuro-cognitive recovery.
- High school athletes are slower to recover from concussion compared with college and professional athletes, even when they have history of fewer concussions

# New Evidence Neuropsychological

- Persistent neuropsychological impairment has been documented in patients whose core concussion symptoms have resolved.
- Studies of college athletes have found neuropsychological deficits in those with > 2 concussions (Clin. In Sports Medicine 2009)
- Retired athletes with 1-2 concussions prior to early adulthood found to have late/progressive declines in attention, memory, and movement. (Brain, 2009)
- Multiple rapid, computer-based neuropsychological tests have been validated for concussion assessment.

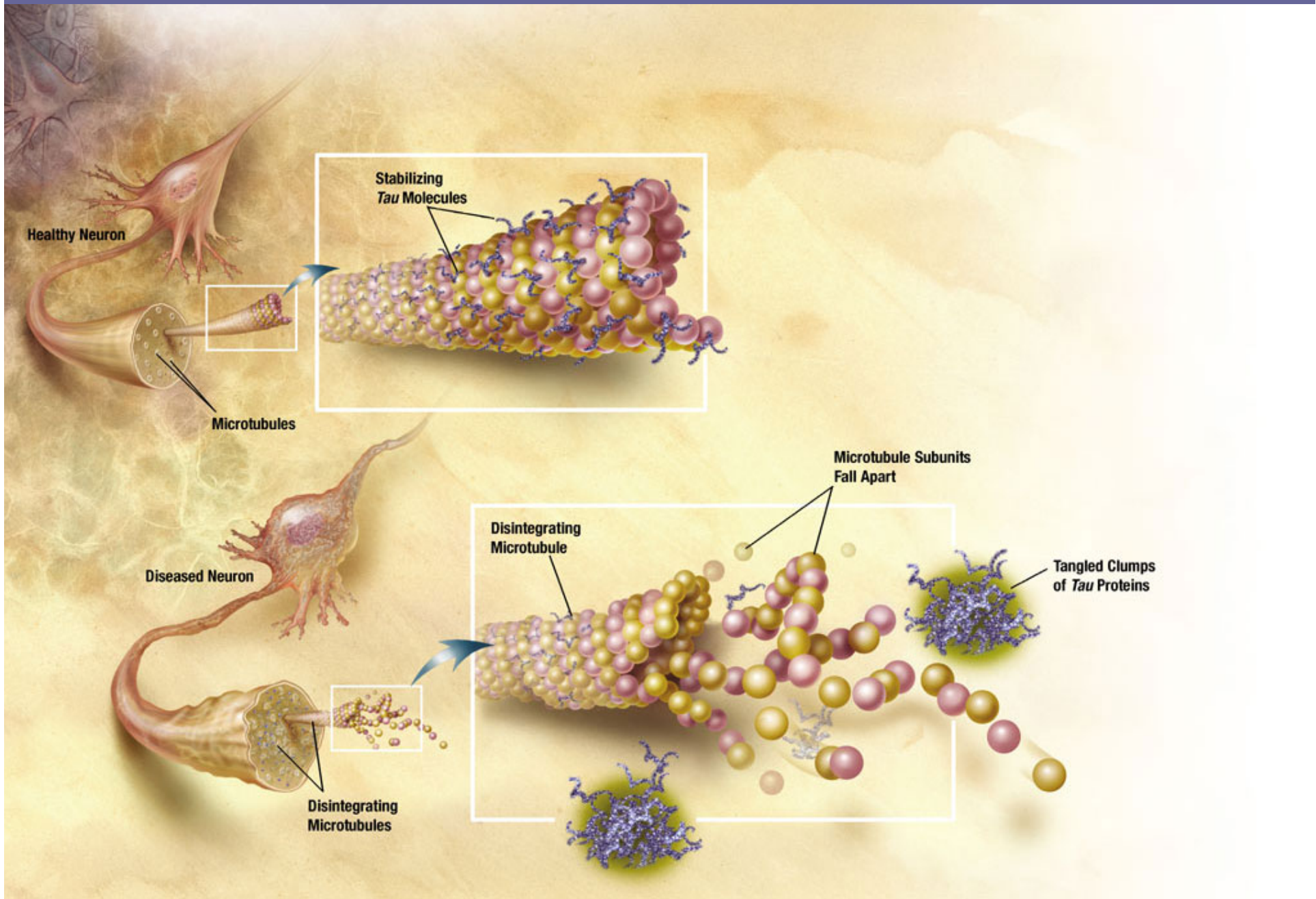
# New Evidence

## Pathophysiological

- Alterations in brain metabolism on functional brain imaging studies have been found to correlate with neuropsychological deficits after concussion.
- Early oxidative metabolic dysfunction leads to chronic brain atrophy in traumatic brain injury (J. Cereb. Blood Flow/Metabolism. Dec. 2009)
- Tau-immunoreactive neurofibrillary tangles found in specific brain areas of deceased athletes with Chronic Traumatic Encephalopathy (J. Neuropathol. Exp. Neurol. Jul. 2009)

# Tau-Microtubule Associated Protein

- Tau proteins are a collection of microtubule associated proteins that act as “molecular glue” that stabilize microtubule.
- Shearing forces and vascular/BBB dysfunction from head trauma cause disintegration of microtubules, leading to tangled clumps of tau protein in neurons.
- Tau aggregation intermediates (granular tau oligomers) appear important in mediating disease pathogenesis in dementia.
  - (Stanley Appel, Texas Neurological Society Feb 2010)



# International Concussion In Sport Conferences (2001, 2004, 2008)

- None of the previous guidelines for management/return to play were adequate.
- Management and return to play decisions should be individualized, rather than following pre-set timetables.
- Emphasized neuropsychological testing as the “cornerstone” of post-concussion management.
- Recommended baseline neuropsychological testing for athletes whenever possible
- Emphasized gradual, step-wise return to play once all signs and symptoms have resolved.

# International Concussion In Sport Conference

## New Return to Play Guidelines

- Remove player with any signs or symptoms of concussion.
- Never return to play on same day.
- Medical evaluation following injury
  - Rule out more serious injury/structural lesion
  - Neuropsychological assessment (compared to baseline where available)
- Gradual, step-wise return to play once all symptoms and signs have resolved.

# International Concussion In Sport Conference

## New Return to Play Guidelines

- Step-wise return to play after all concussion signs and symptoms have resolved
  - Light aerobic activity (stationary bike or jogging)
  - Sport-specific training (sprints, weight lifting)
  - Non-contact drills
  - Full-contact drills/practice
  - Competition/game play
- At least 24 hours between each step
- If any symptoms or signs return during activity, return to previously level for at least 24 hours

# Concussion

## Take home points

- Repeat head trauma before full recovery from concussion can be very dangerous
- While most patients recovery completely, some may develop long-term and progressive neurological deficits, even after a single concussion.
- Previous return-to - play timetables based on grading of concussion have been replaced by individualized management based on each athletes course of recovery.
- Rest is the primary treatment for concussion.
- Once full recovery has been documented, return to play should follow a gradual, step-wise process, with return to lower level of activity if any symptoms or signs return.

