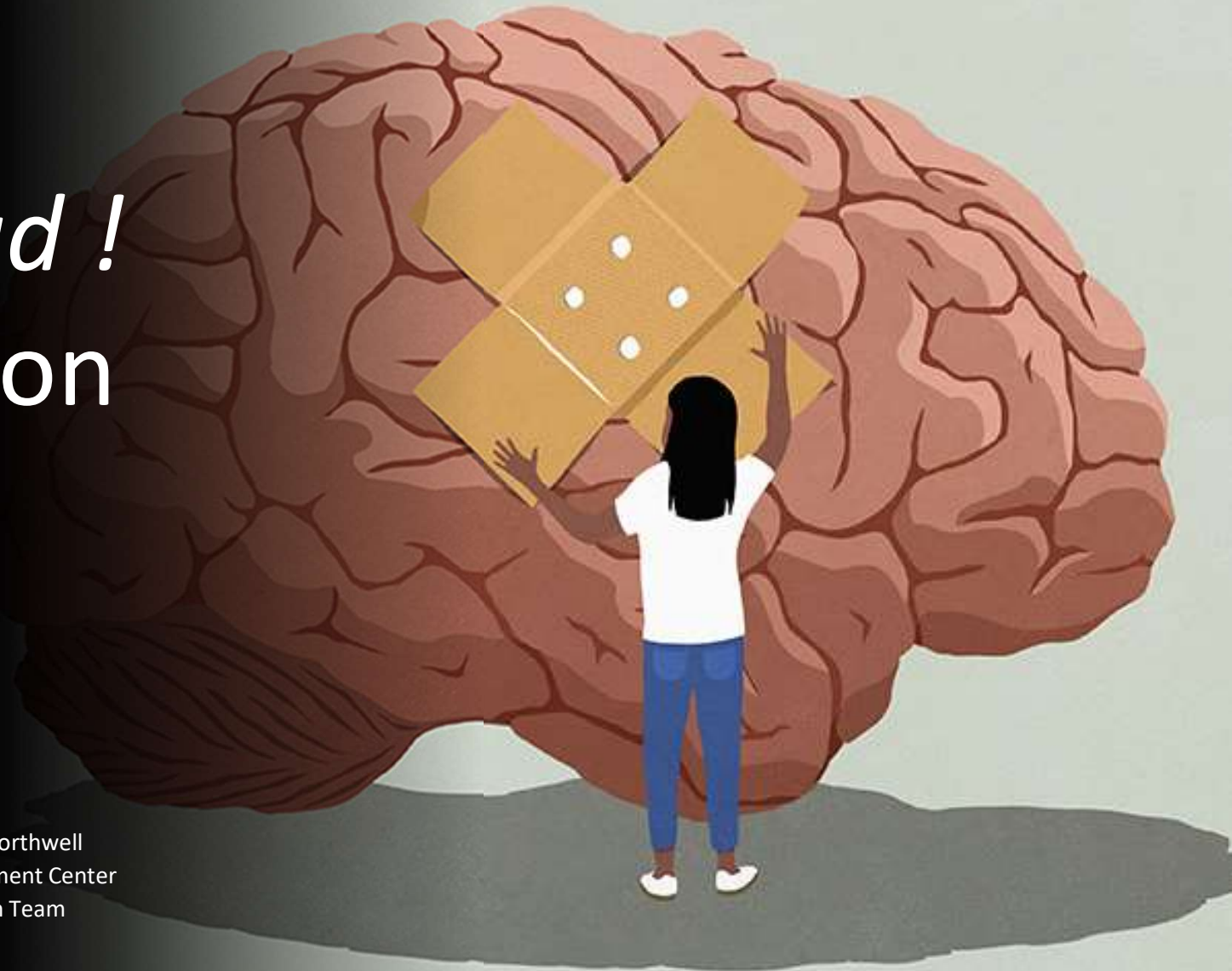# *Its All In Your Head !* Concussion and…

Robert A. Duarte, MD

Associate Professor
Department of Neurology
Zucker School of Medicine at Hofstra/Northwell
Director of Neuroscience Pain Management Center
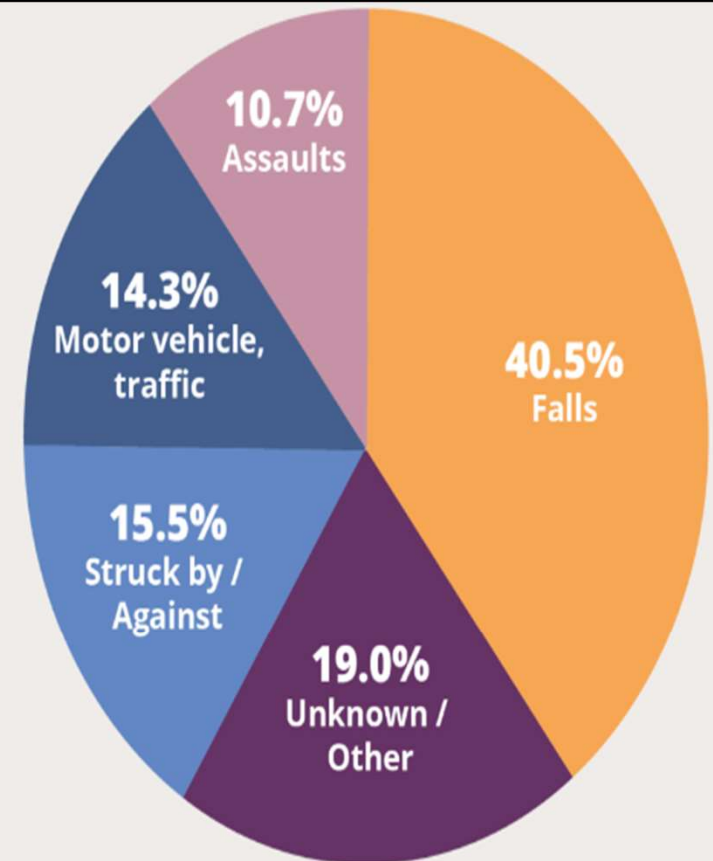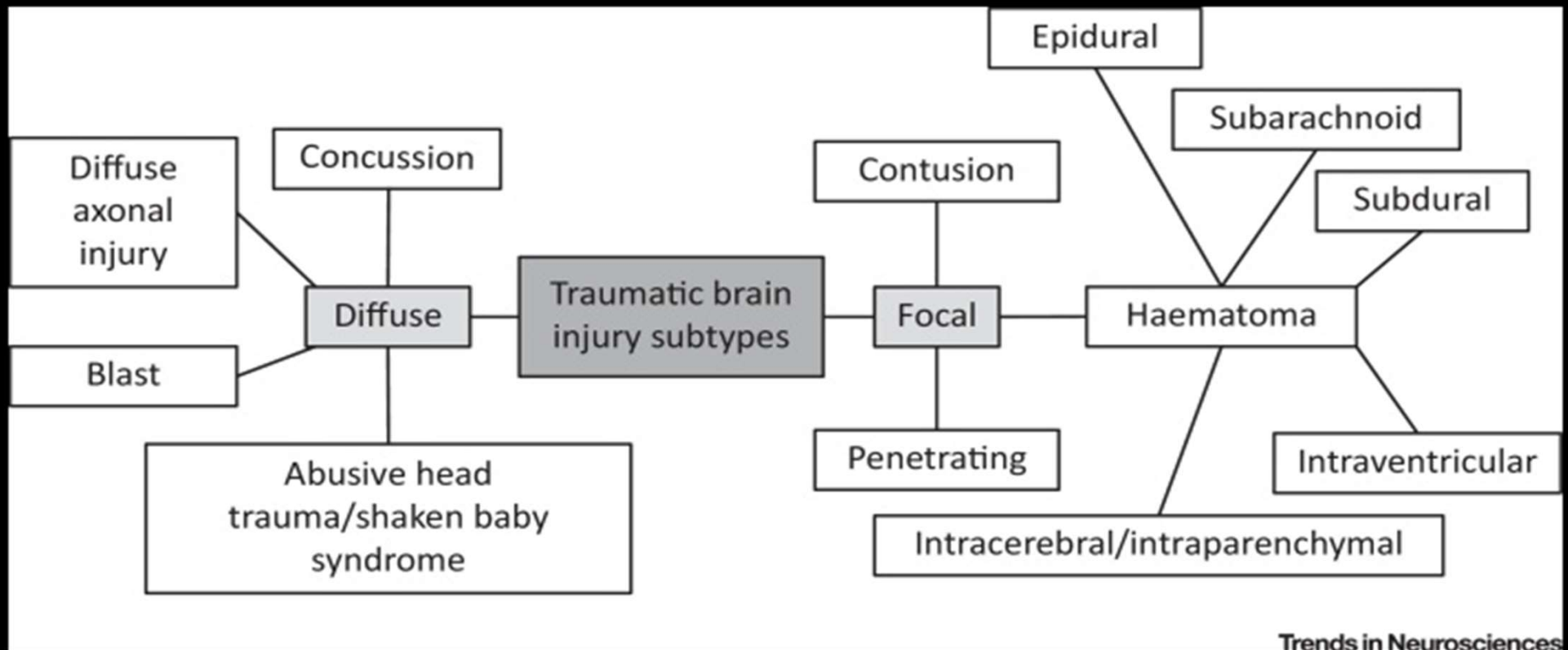Lead Neurologist, Northwell Concussion Team

Disclaimer

My presentation and its recording are based on my current knowledge and meant for educational purposes only and should not be used as a reference in any legal matter.

Traumatic Brain Injury

- 2.8 million Americans sustain a traumatic brain injury every year.

- From 2006 to 2014, the number of TBI-related emergency department visits, hospitalizations, and deaths increased by 53%.

- In 2014, an average of 155 people in the United States died each day from injuries that include a TBI.

- More than 56,000 people die every year as a result of TBI.

- Traumatic brain injury (TBI) disables SIX times more people each year than spinal cord injuries, multiple sclerosis, HIV/AIDS, and breastcancer combined.

- 5.3 million Americans currently have a long-term or lifelong need for help to perform activities of daily living as a result of TBI.

- From 2001 to 2009, the rate of ED visits for sports and recreation-related injuries with a diagnosis of concussion or TBI, alone or in combinations with other injuries, rose 57% among children (age 20 or younger).

- 300,000 sport and recreation-related concussions are diagnosed nationwide each year with a possible seven times more going undiagnosed.

- From 2006 to 2010, falls were the leading cause of TBI, accounting for 40% of all TBI's in the United States that resulted in an ED visit, hospitalization or death. Falls disproportionately affect the youngest and oldest age groups.

- About 10% of all TBI's are due to assaults.

- Motor vehicle crashes were the leading cause of TBI-related death for children and young adults ages 5-24 years.

- Young children, teenagers and seniors are most likely to sustain a TBI.

- Although everyone is at risk, males are approx. 1.5 times more likely than females to sustain a TBI and 3 times as likely to die.


Pie chart:
- 40.5% Falls
- 19.0% Unknown / Other
- 15.5% Struck by / Against
- 14.3% Motor vehicle, traffic
- 10.7% Assaults

Traumatic Brain Injury Subtypes

Trends in Neurosciences

Categorization of Traumatic Brain Injury	Mild TBI / Concussion	Moderate TBI	Severe TBI
Glasgow Coma Scale (GCS)	13 - 15	9 - 12	3 - 8
Post Traumatic Amnesia (PTA)	< 24 hours	24 hours - 7 days	> 7 days
Loss of Consciousness (LOC)	0 - 30 mins	30 mins - 24 hours	> 24 hours
Medical Imaging	Typically unremarkable	Some findings	Significant findings

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Mechanism of TBI
Let's Review
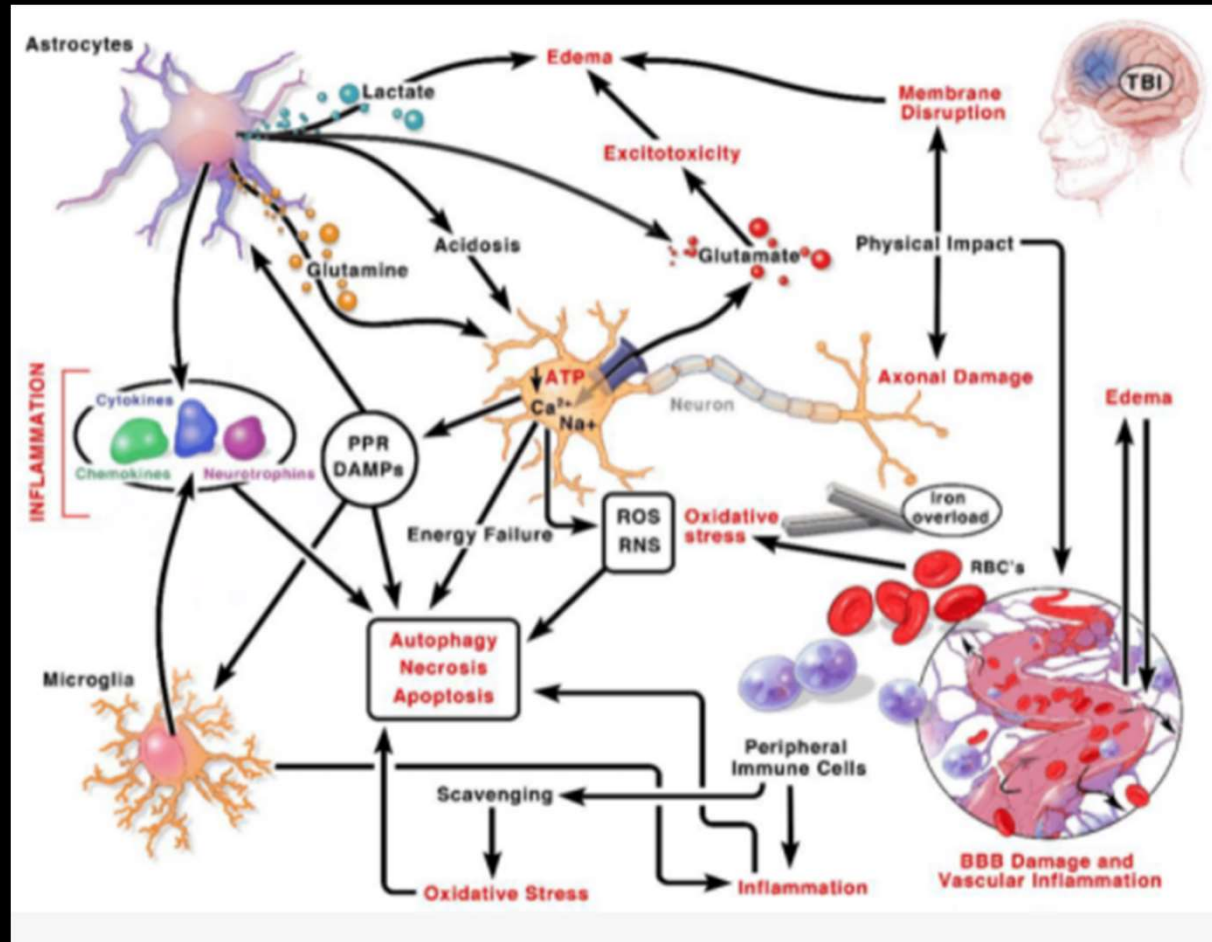
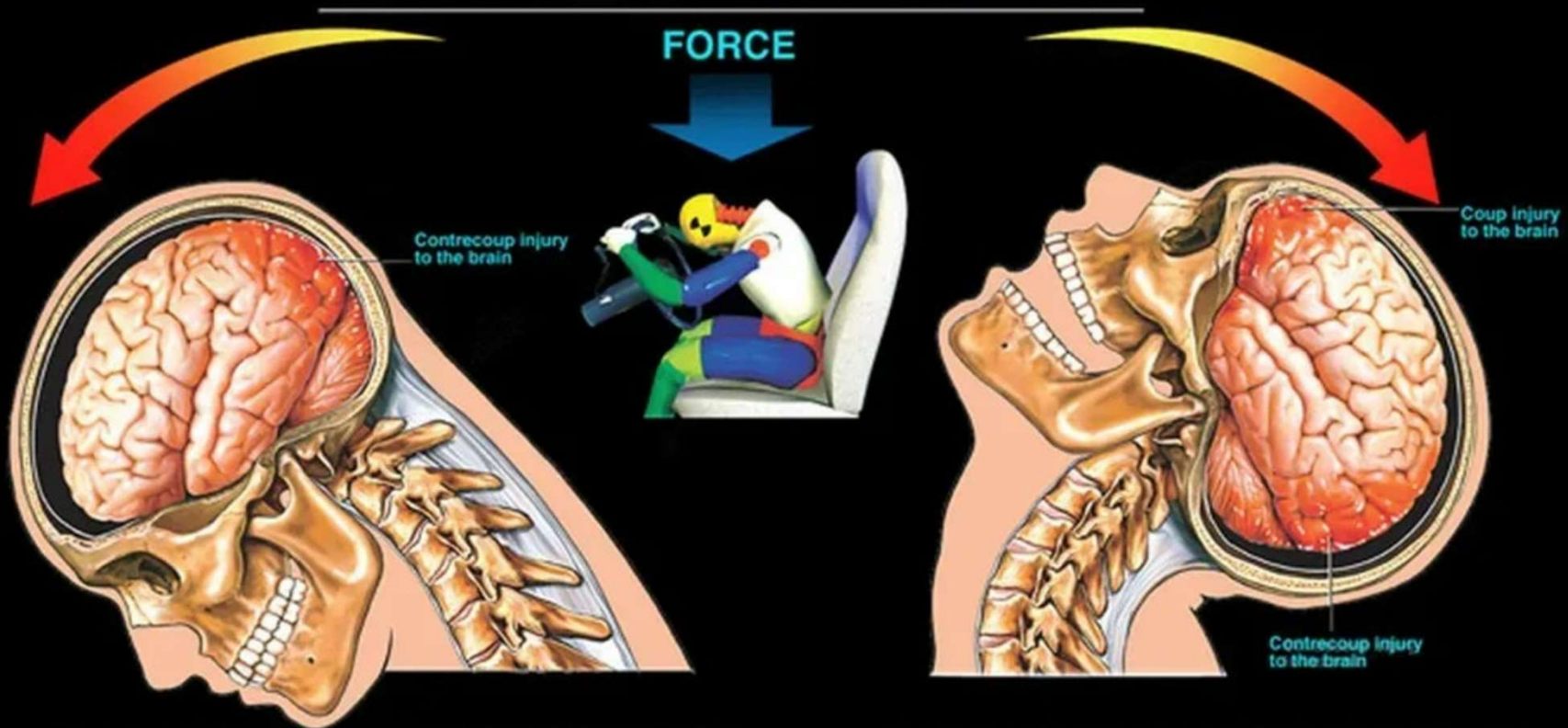**Direct impact brain injury**

Brain

Skull
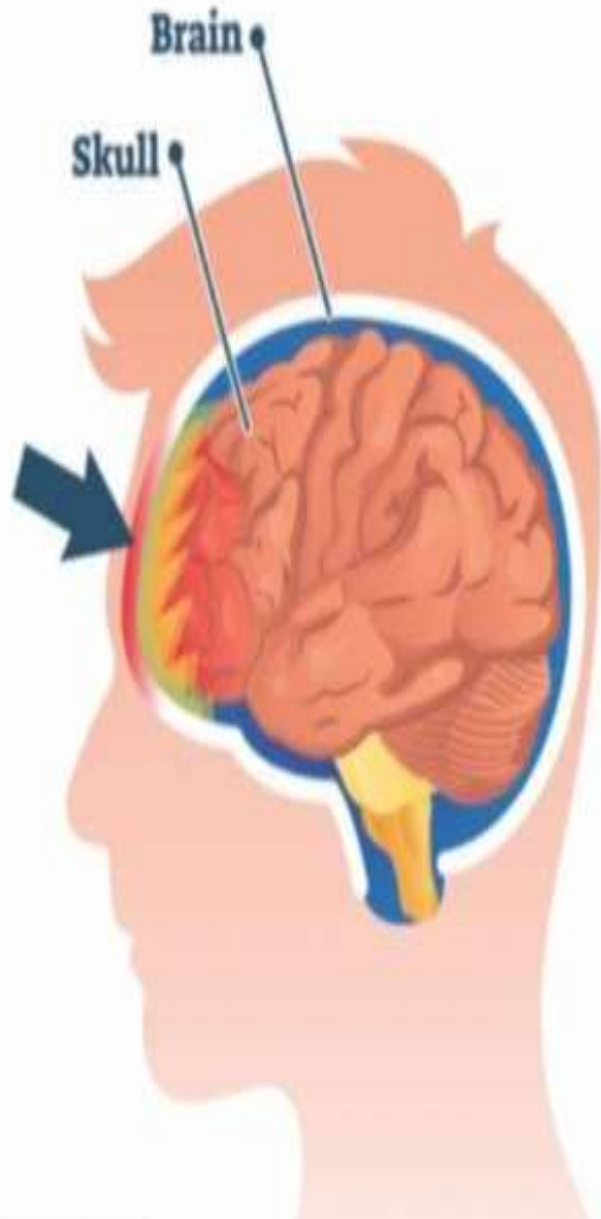
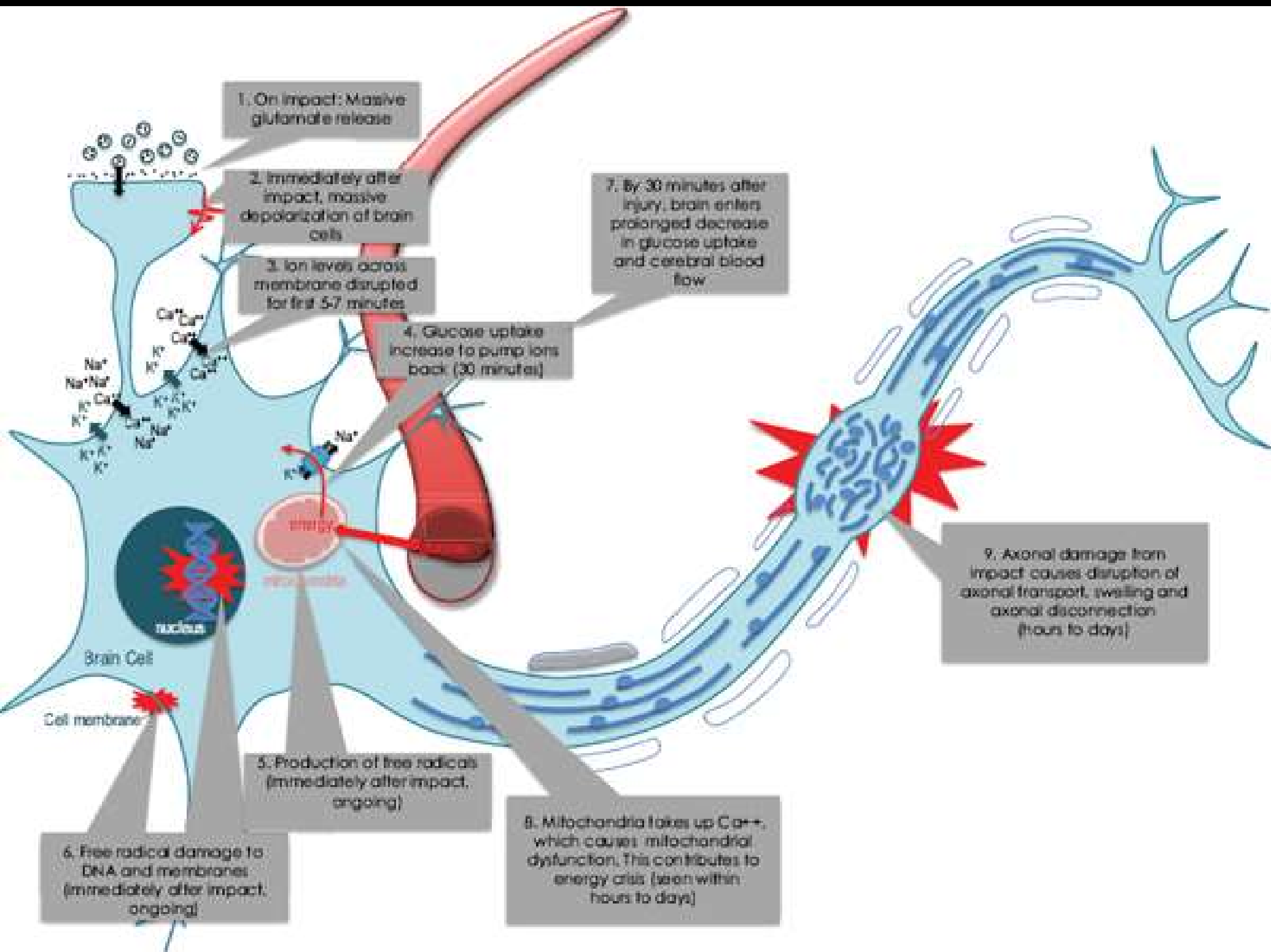**Acceleration-deceleration brain injury**

Blast brain injury
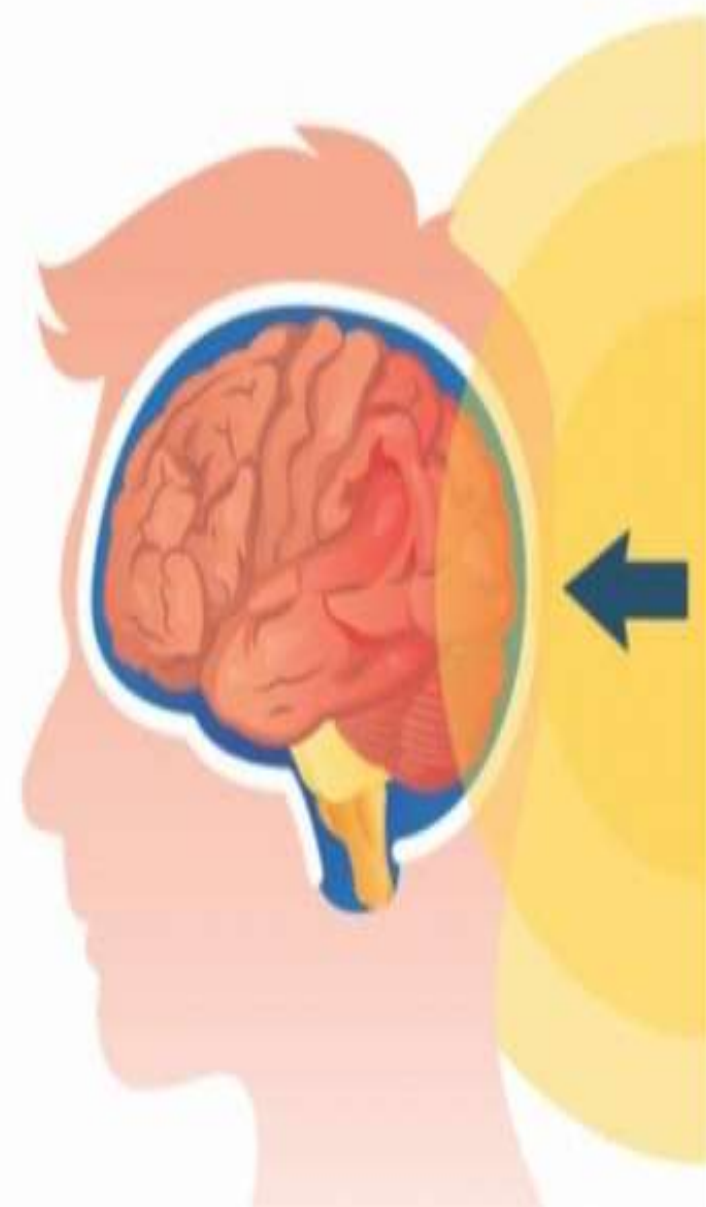
Coup / Contrecoup

1. On impact: Massive glutamate release

2. Immediately after impact, massive depolarization of brain cells

3. Ion levels across membrane disrupted for first 5-7 minutes

4. Glucose uptake increase to pump ions back (30 minutes)

7. By 30 minutes after injury, brain enters prolonged decrease in glucose uptake and cerebral blood flow

5. Production of free radicals (immediately after impact, ongoing)

6. Free radical damage to DNA and membranes (immediately after impact, ongoing)

8. Mitochondria takes up Ca++, which causes mitochondrial dysfunction. This contributes to energy crisis (seen within hours to days)

9. Axonal damage from impact causes disruption of axonal transport, swelling and axonal disconnection (hours to days)

Brain Cell

nucleus

energy

Cell membrane

Primary injury

- Skull fracture
- Cerebral laceration
- Cerebral contusion
- Vascular dissection and haemorrhage
- blood brain barrier compromise
- Diffuse axonal injury
- Release of cytokine, chemokine and damage associated molecular pattern
- Necrotic cell death

Time (minutes to days)

Secondary injury

- Cerebral blood flow deregulations
- Increase in intracranial pressure and oedema
- Hypoxic ischemia
- Neuroinflammation
- Calcium influx and excitotoxicity
- Mitochondrial dysfunction
- Generation of oxidative stress
- Impaired autophagy
- Axonal degeneration and neuronal death

Time (months to years)

Neurobehavioral deficits

- Cognitive dysfunctions (memory, executive function, language, attention, visuospatial cognition)
- Anxiety disorder, depression, mania, PTSD, psychosis, seizures
- Sensory disruptions (visual disturbances, dizziness, hearing loss, altered smell perception, altered taste, smell and touch perceptions)
- Sleep disturbances
- Somatic symptoms (headache, chronic pain, loss of libido, fatigue)
- Substance abuse disorder

Concussion

Definition:

- Concussion is a temporary injury to the brain caused by a bump, blow or jolt to the head. – NHS

- A concussion is an injury to the brain that results in temporary loss of normal brain function. – AANS

- Is a disturbace in brain function caused by direct or indirect force to the head. Resulting in a variety of non-specific signs and/or symptoms and most often does not involve loss of consciousness – SCAT3

Acute Concussion

Immediate/ Early Clinical Signs

Woozy, "a ding"

Headache

Dizziness

Blurry vision

Imbalance

Light/Noise sensitivity

Decrease in cognition

Poor sleep

Mood changes
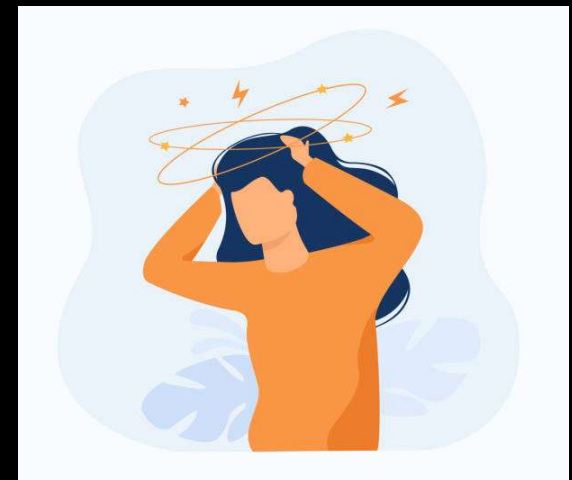
Physical Examination

Observation, *Observation*,

Observation !!!

Mini-Mental State Examination (MMSE)

Patient's Name: _____   Date: _____

Instructions: Ask the questions in the order listed.
Score one point for each correct response within each question or activity.

Maximum Score	Patient's Score	Questions
5		"What is the year? Season? Date? Day of the week? Month?"
5		"Where are we now: State? County? Town/city? Hospital? Floor?"
3		The examiner names three unrelated objects clearly and slowly, then asks the patient to name all three of them. The patient's response is used for scoring. The examiner repeats them until patient learns all of them, if possible. Number of trials: _____
5		"I would like you to count backward from 100 by sevens." (93, 86, 79, 72, 65, …) Stop after five answers. Alternative: "Spell WORLD backwards." (D-L-R-O-W)
3		"Earlier I told you the names of three things. Can you tell me what those were?"
2		Show the patient two simple objects, such as a wristwatch and a pencil, and ask the patient to name them.
1		"Repeat the phrase: 'No ifs, ands, or buts.'"
3		"Take the paper in your right hand, fold it in half, and put it on the floor." (The examiner gives the patient a piece of blank paper.)
1		"Please read this and do what it says." (Written instruction is "Close your eyes.")
1		"Make up and write a sentence about anything." (This sentence must contain a noun and a verb.)
1		"Please copy this picture." (The examiner gives the patient a blank piece of paper and asks him/her to draw the symbol below. All 10 angles must be present and two must intersect.)
30		TOTAL

Neurological Examination

"W.N.L."

Mental Status
- MMSE
- MoCA

Ganser's syndrome

Montreal Cognitive Assessment (MoCA) form

- **Montreal cognitive Assessment Score: A Screening Tool for Cognitive Function in Traumatic Brain Injury (TBI) Population**

- Keshav Mishra1, Devendra Purohit1*, Somnath Sharma1

- 1Department of Neurosurgery, SMS Medical College, Jaipur, India

- Abstract

- Cognitive impairment is a major cause of morbidity and impaired quality of life in traumatic brain Injury (TBI) patients. Assessment of cognitive function using classically designed scales is time and resource intensive undertaking which also requires expert neuropsychiatrist referral. **Montreal cognitive assessment Score (MoCA)** is a brief screening tool designed to assess various cognitive domains which has been found to be **more sensitive than Mini Mental State Examination (MMSE) score both in Alzheimer disease and subsequently in TBI population.** Applied on TBI population, it **reliably detects cognitive impairment in mild TBI**, compared to normal controls and also **differentiates cognitive disturbances between mild and severe TBI but its ability to differentiate cognitive function between mild and moderate TBI is equivocal.**

Neurological Exam continued

- Cranial Nerve 1-12
- Motor/sensory/DTR
  - Give way weakness
  - Not dermatomal
- Balance/gait
  - BESS (mofified)
- Musculoskeletal
  - Tenderness/spasm
  - ROM
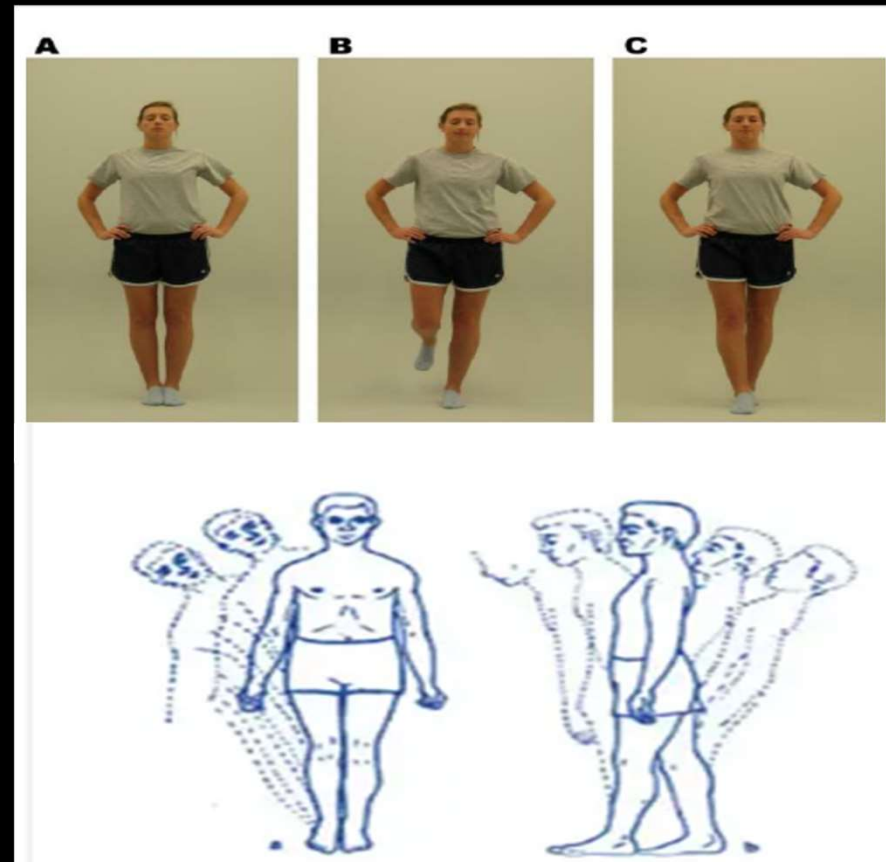
Red Flags for Malingering

Gordon Waddell, MD

- Superficial non-anatomic tenderness
- Pain from maneuvers that should **not** ellicit pain
- Distraction maneuvers that should ellicit pain **BUT** don't
- Disturbances not consistent with known patterns of pain
- Over-reacting during the exam
- Not definitive to rule out organic disease

Workup

Concussion

Imaging

CT scan vs MRI

R/o structural abnormality

Diffusion Tensor Imaging (DTI) experimental only at this point

Not recommended for prognostic purposes
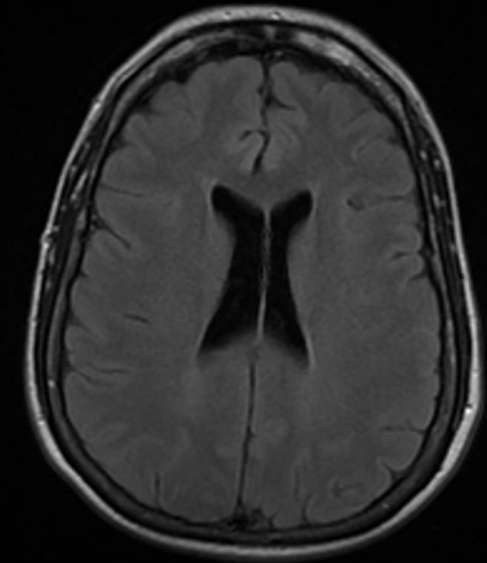
Diffusion Tensor Imaging of TBI: Potentials and Challenges

David B. Douglas, MD,[*] Michael Iv, MD,[*] Pamela K. Douglas, PhD,[†] Anderson Ariana, PhD,[†] Sjoerd B. Vos, PhD,[‡] Roland Bammer, PhD,[*] Michael Zeineh, PhD, MD,[*] and Max Wintermark, MD[*]

In conclusion, DTI techniques are sensitive for TBI at the group level only for population-based research. There remains insufficient evidence at the present time to suggest that DTI plays a clinical role in patients with TBI at the individual level.[72,73]

Current State of Diffusion-Weighted Imaging and Diffusion Tensor Imaging for Traumatic Brain Injury Prognostication

Matthew Grant, MD[a,b,c,*], JiaJing Liu, MD, PhD[a], Max Wintermark, MD[a,d], Ulas Bagci, PhD[e,f], David Douglas, MD[a,g]

KEY POINTS

- Diffusion tensor imaging (DTI) generally shows low fractional anisotropy (FA) and high mean diffusivity (MD) values in patients with TBI-related injury. However, many diseases can also show altered FA and MD values. Results should therefore be interpreted with caution and in the full clinical context.

- A key limitation of DTI is its inability to resolve crossing white matter tract fibers within a voxel. Advanced techniques, such as diffusion kurtosis imaging (DKI), can better resolve this at the expense of increased imaging time and more involved computing.

- Although research shows a general trend toward low FA values in TBI patients, this can only be said at the group level and exact cutoffs differentiating normal versus abnormal have not yet been established to allow these data to be applied to individual patients. Future research will better clarify this.

Serum Biomarkers

March 7, 2023

Approved age 18+, mild TBI, within 12 hours of injury

UCH-L1 (Ubiquitin C-terminal Hydrolase) and GFAP (Glial Fibrillary Acidic Protein), whole blood sample

Does not diagnose concussion, only structural brain injury to determine need for CT scan

Additional Testing?

- **Electrodiagnostics**

  - EEG
  - EMG
  - Other

Pearls of Consensus Statement 2022

Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport–Amsterdam, October 2022 FREE

Jon S Patricios [1], Kathryn J Schneider [2], Jiri Dvorak [3], Osman Hassan Ahmed [4,5], Cheri Blauwet [6,7], Robert C Cantu [8,9], Gavin A Davis [10,11], Ruben J Echemendia [12,13], Michael Makdissi [14,15], Michael McNamee [16,17], Steven Broglio [18], Carolyn A Emery [2], Nina Feddermann-Demont [19,20], Gordon Ward Fuller [21], Christopher C Giza [22,23], Kevin M Guskiewicz [24], Brian Hainline [25], Grant L Iverson [26,27], Jeffrey S Kutcher [28], John J Leddy [29], David Maddocks [30], Geoff Manley [31], Michael McCrea [32], Laura K Purcell [33], Margot Putukian [34], Haruhiko Sato [35], Markku P Tuominen [36], Michael Turner [37,38], Keith Owen Yeates [39], Stanley A Herring [40,41], Willem Meeuwisse [42]

The results of computerised neurocognitive tests should be interpreted in the context of broader clinical findings and are not to be used in isolation to inform management or diagnostic decisions.

Advanced neuroimaging, fluid-based biomarkers, genetic testing and emerging technologies are valuable research tools for the study of concussion but not yet suited for routine use in clinical practice.

Treatment

"NOW, FIRST THING YOU DO WHEN YOU GET HOME IS TO RAISE YOUR CEILING FAN."

Concussion

Current Treatment

Rest period: 24-48 hours

Electronics as tolerated

Management of headaches, vertigo, neck sprain

Return to school: progressive, if needed

Return to work incumbent upon

Nature of employment, symptoms

Return to Gym/Contact Sports/Athletics

6-stage process

Concussion

Treatment:

Good Sleep Hygiene

Many symptoms can be exacerbated by poor sleep and changes in normal sleep cycle

- Stick to a sleep schedule
- Avoid day napping
- Avoid distractions and TV/electronics in bed
- Melatonin can help some people to restore sleep cycle
  - 1-10 mg 30-60 minutes before bed

Concussion

Treatment - No FDA approved medication

Headache – Migraine vs…

- Acetaminophen
- Dexamethasone (brief course 0-4 weeks post injury)
- Methylprednisolone dose pack.
- Preventative vs Abortive

Occipital headaches (back of head)

- Neck sprain– muscle relaxants, NSAID
- Nerve blocks

Vertigo (positional)

- Meclizine prn

Effectiveness of Vestibular Rehabilitation after Concussion: A Systematic Review of Randomised Controlled Trial

Erasmo Galeno, Conceptualization, Validation, Writing – original draft, Supervision,[1,2] Edoardo Pullano, Conceptualization, Data curation, Visualization,[3] Firas Mourad, Methodology, Validation, Supervision,[4,5] Giovanni Galeoto, Methodology, Visualization, Supervision,[6] and Francesco Frontani, Conceptualization, Methodology, Formal analysis, Writing – original draft[3,*]

Mustafa Z. Younis, Academic Editor

VR seems to be a valid approach for the management of patients suffering from dizziness after concussive trauma. VR seems to reduce the time to clearance to RTS in the acute phase and to modify quality of life and gait impairment symptoms in patients who have suffered an mTBI. Moreover, a meta-analysis showed that DHI scores improved significantly in the short term ($p < 0.01$). Considering this relevant outcome, VR could be a valid approach in the short term. We need more studies with higher magnitude and that properly consider the time elapsed since concussion to detect the correct approaches and dosage.

Vestibular Rehabilitation as an Early Intervention in Athletes Who are Post-concussion: A Systematic Review

Gabrielle Babula, Edward Warunek, Katherine Cure, Grace Nikolski, Heather Fritz, Susan Barker

CONCLUSION

Beginning vestibular rehabilitation therapy as early as 10 to 14 days post-concussion does not appear to be detrimental to an athlete's healing and may help to reduce recovery time and time to return to sports. However, more data collection is needed to further determine the effectiveness of VRT as an early intervention in reducing post-concussion symptoms and decreasing recovery

Concussion

Outpatient follow-up

Monthly visits until resolution

Vestibular therapy, Vision (Ocular) therapy

Physical therapy, Medications

If prolonged (>1-3 months)

Neuropsychological evaluation if memory/concentration a problem

Cognitive therapy

Medication for depression, anxiety

Psychological counselling

Neuropsychological assessment

- Assessment of symptom exaggeration (SVT)
- Intellect – pre-injury and current. Assessment of pre-injury intellect is very difficult in children
- Mental speed
- Memory
- Executive function
- Communication
- Visuospatial and visuomotor function

literature review

Is Neuropsychological Testing Useful in the Management of Sport-Related Concussion?

Christopher Randolph*; Michael McCrea†; William B. Barr‡

Conclusions/Recommendations: Despite the theoretic rationale for the use of NP testing in the management of sport-related concussion, no NP tests have met the necessary criteria to support a clinical application at this time. Additional research is necessary to establish the utility of these tests before they can be considered part of a routine standard of care, and concussion recovery should be monitored via the standard clinical examination and subjective symptom checklists until NP testing or other methods are proven effective for this purpose.

Review

Neuropsychological Assessment in Patients with Traumatic Brain Injury: A Comprehensive Review with Clinical Recommendations

William Torregrossa [1,†], Michele Torrisi [1,†], Rosaria De Luca [1], Carmela Casella [2], Carmela Rifici [1], Mirjam Bonanno [1,*] and Rocco Salvatore Calabrò [1]

POST CONCUSSION SYNDROME

A. A history of head trauma that has caused significant cerebral concussion.

B. Evidence from neuropsychological testing or quantified cognitive assessment of difficulty in attention or memory.

C. Three (or more) of the following occur shortly after the trauma and last at least three months:
1. becoming fatigued easily
2. disordered sleep
3. headache
4. vertigo or dizziness
5. irritability or aggression on little or no provocation
6. anxiety, depression, or affective lability
7. changes in personality (e.g., social or sexual inappropriateness)
8. apathy or lack of spontaneity

D. The symptoms in criteria B and C have their onset following head trauma or else represent a substantial worsening of preexisting symptoms.

E. The disturbance causes significant impairment in social, occupational or academic functioning.

F. The symptoms do not meet criteria for another disorder.

Risk Factors for PCS

Recurrent Head Trauma

Female

Older Age

H/O Psychiatric illness / Chronic pain

- Somatization disorder

Litigation

Chronic Traumatic Encephalopathy

CTE

Repetitive brain injury

- Dementia pugilistica in boxers
- Now seen in other sports (football)

Possible repetitive axonal stretching and deformation, esp in those with unresolved concussive events.

Chronic Traumatic Encephalopathy

Clinical Features

Early

- Short-term memory impairment
- Cognitive dysfunction (planning, organization)
- Depression/apathy
- Emotional Instability
- Impulse control problems
- Suicidality

Chronic Traumatic Encephalopathy

Clinical Features:

Late

Dementia, Parkinsonism

CTE NOT INEVITABLE AFTER REPETITIVE TBI

More research needed about the long-term effects of repetitive head impacts. Not enough evidence to make conclusions.

The key is caution and to prevent further concussions, in general, especially while still in healing process.

Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport–Amsterdam, October 2022   FREE

Jon S Patricios [1], Kathryn J Schneider [2], Jiri Dvorak [3], Osman Hassan Ahmed [4,5], Cheri Blauwet [6,7], Robert C Cantu [8,9], Gavin A Davis [10,11], Ruben J Echemendia [12,13], Michael Makdissi [14,15], Michael McNamee [16,17], Steven Broglio [18], Carolyn A Emery [2], Nina Feddermann-Demont [19,20], Gordon Ward Fuller [21], Christopher C Giza [22,23], Kevin M Guskiewicz [24], Brian Hainline [25], Grant L Iverson [26,27], Jeffrey S Kutcher [28], John J Leddy [29], David Maddocks [30], Geoff Manley [31], Michael McCrea [32], Laura K Purcell [33], Margot Putukian [34], Haruhiko Sato [35], Markku P Tuominen [36], Michael Turner [37,38], Keith Owen Yeates [39], Stanley A Herring [40,41], Willem Meeuwisse [42]

CTE-NC is not a clinical diagnosis. The first consensus criteria for traumatic encephalopathy syndrome (TES), a new clinical diagnosis, were published in 2021.[87] These diagnostic criteria can be used to determine the extent to which CTE-NC identified after death was associated with this new clinical diagnosis during life. The prevalence of CTE-NC (a neuropathological entity) and TES (a clinical diagnosis) in former athletes, military veterans and people from the general population is not known. It is also not known whether (1) CTE-NC causes specific neurological or psychiatric problems, (2) the extent to which CTE-NC can be clearly identified within the presence of Alzheimer's disease neuropathology or (3) whether CTE-NC is inevitably progressive.

TEAM MEMBERS
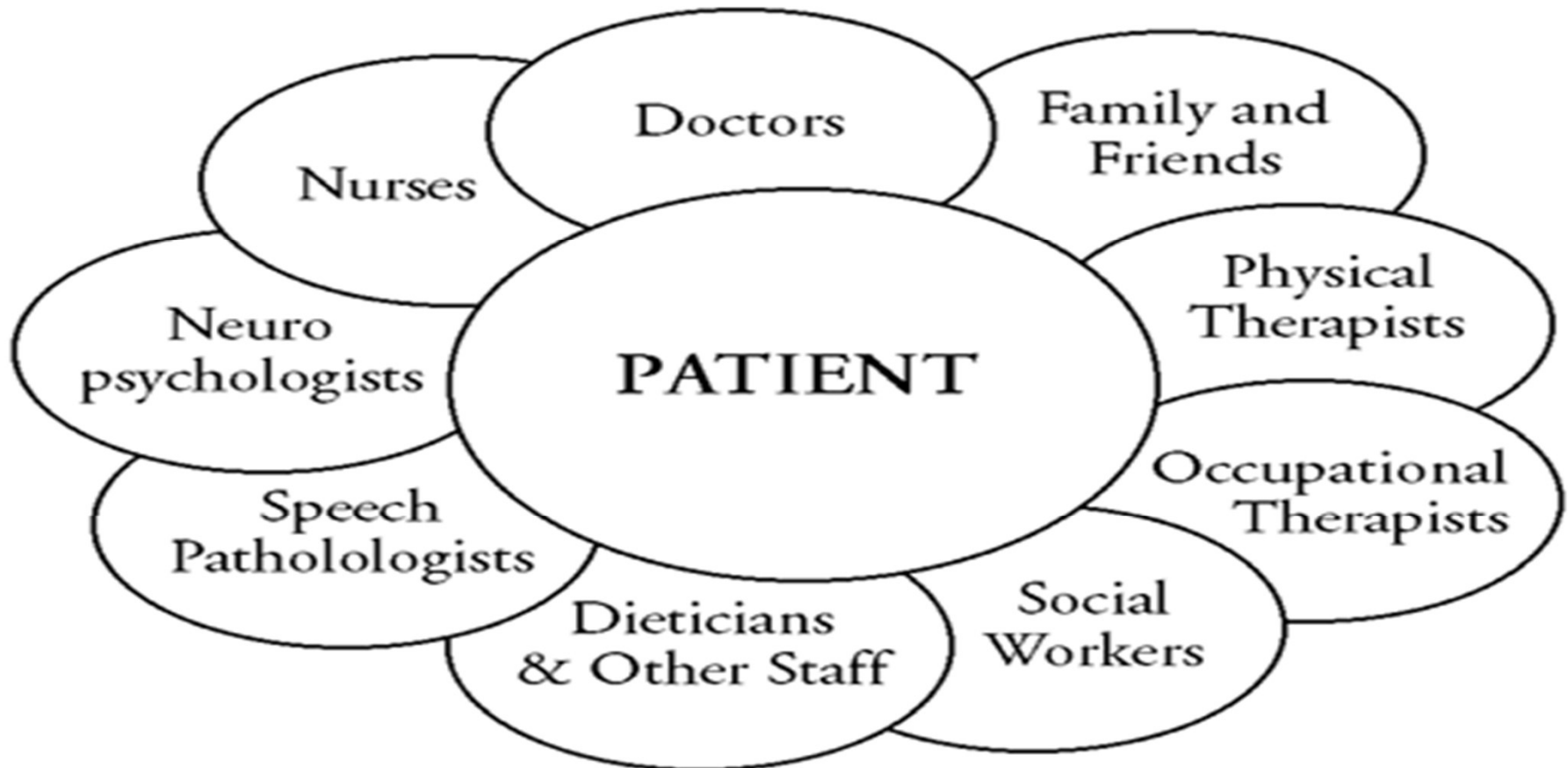
The **Northwell Health Concussion Program** provides advanced concussion management and treatment in alignment with current evidence based guidelines for athletic and non-athletic populations.

Our Services Include:

Physician Consultation for Concussion and Traumatic Brain Injury

Our physicians practice evidence-based concussion management guidelines for patients of all ages and all injuries. *To enter into the program, a patient must be evaluated by a physician.*

Neuropsychology Consultation and Neurocognitive Testing

If needed, neuropsychologists can assess and treat cognitive and/or emotional difficulties that may present in the context of a suspected concussion, such as difficulty with concentration and remembering, anxiety and depression.

Vestibular and Balance Rehabilitation

Vestibular therapy can help improve dizziness and restore balance and coordination.

Physical Therapy

Agility and performance for return to sports can be maximized with physical therapy as part of the recovery in certain athletes.

Return-to-School

Our clinicians will work with students and provide appropriate accommodations to ensure help is provided where needed.

Return-to-Play and Sports

Our clinicians will communicate with athletic teams and schools to ensure that return to play is done correctly and safely. Baseline testing and post injury evaluations can be used on some athletes using state-of-the-art concussion software on iPads.

Return-to-Participation — Work and Leisure

The goal of our clinicians is to assist in improving function and reintegration into work and daily activities.

Northwell Health℠

1-855-510-5110

THANK YOU!!!