Traumatic Brain Injuries

SCOR Global Life Americas
August 2018

SCOR The Art & Science of Risk | Life

Today's Presenter

Terry Feeney
Underwriting Director
SCOR Global Life Americas

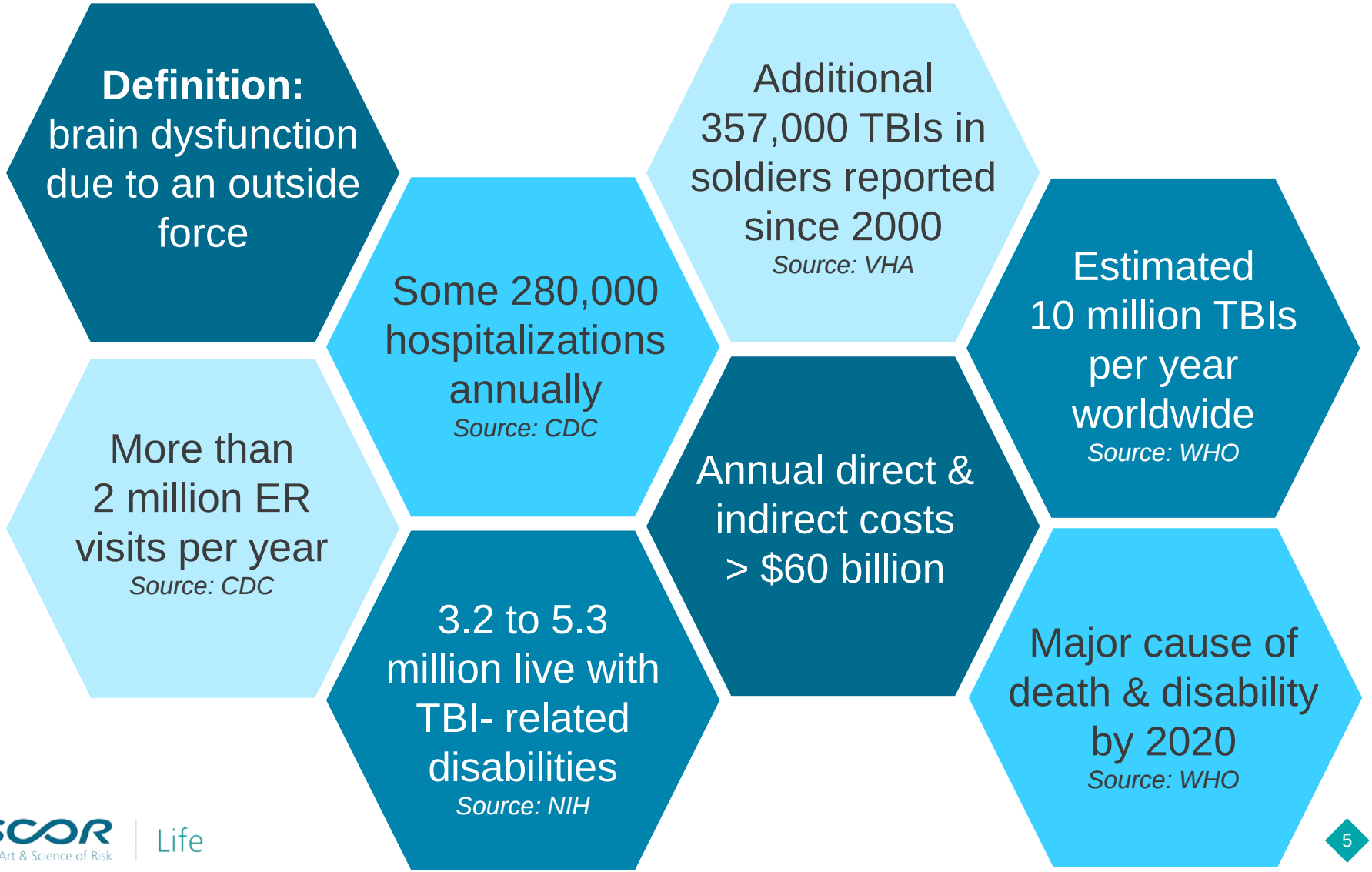
- 35 years underwriting experience with 12 years in direct Life insurance underwriting and 23 years with Transamerica Re and SCOR
- Manages nine underwriters for SGL Americas
- Provides underwriting assessments for product pricing
- Assists Latin America with auditing and training
- Earned bachelor of science at the University of Maryland in College Park
- Active in both national and local underwriting organizations
  - Currently serves on the AHOU Education Committee and is President of the Carolina Underwriters Forum
  - Past service includes the AHOU Program Committee and the Underwriting Procedures and Cost Committee
- Credentials include Fellow of Academy of Life Underwriting; Fellow, Life Management Institute; and Associate, Customer Service

Agenda

1. Introduction
2. Causes of Injuries
3. Diagnosis
4. Symptoms and Classification
5. Treatment
6. Prognosis and Recovery
7. Underwriting Considerations

Introduction

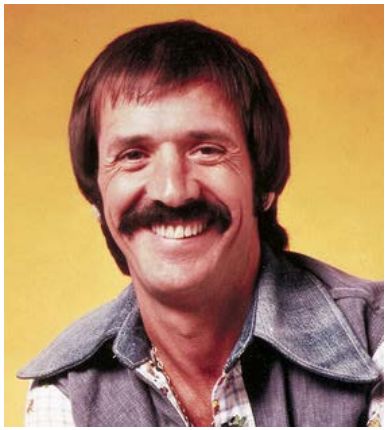
Impact of Traumatic Brain Injuries



Celebrity Deaths Attributed to Traumatic Brain Injuries

Natasha Richardson

- Wife of Liam Neeson
- Daughter of Vanessa Redgrave
- Died of a head injury due to a skiing accident on March 18, 2009



Sonny Bono

- Ex-husband of Cher
- Died of a head injury due to a skiing accident on January 5, 1998

Famous People Living with Traumatic Brain Injuries

Tracy Morgan

- Comedian injured in motor vehicle accident on June 8, 2014
- Recovery lasted more than two years

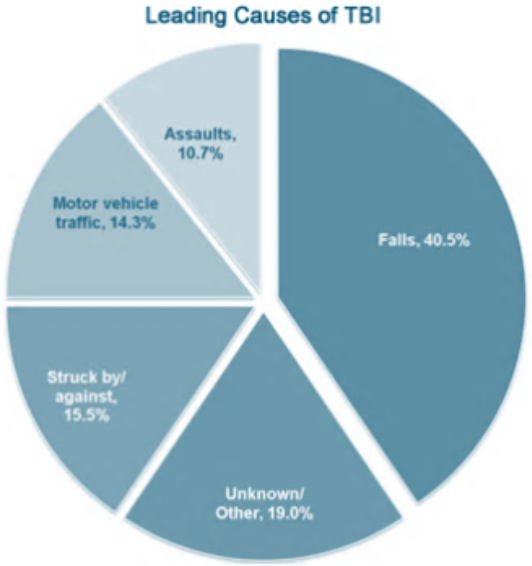
Gabby Giffords

- Arizona congresswoman shot in the head on January 8, 2011
- Skull fracture killed some brain tissue
- Years in recovery to relearn basics to walk, talk and write

Causes of Injuries

Causes of Brain Injuries

- Blows to the head
- Sudden rapid acceleration or deceleration of the body:
  - Falls
  - Vehicular collisions
  - Violence: shaken baby syndrome, domestic abuse and gunshot wounds
  - Sports: contact, extreme or highly competitive
  - Explosive blasts, especially in military personnel



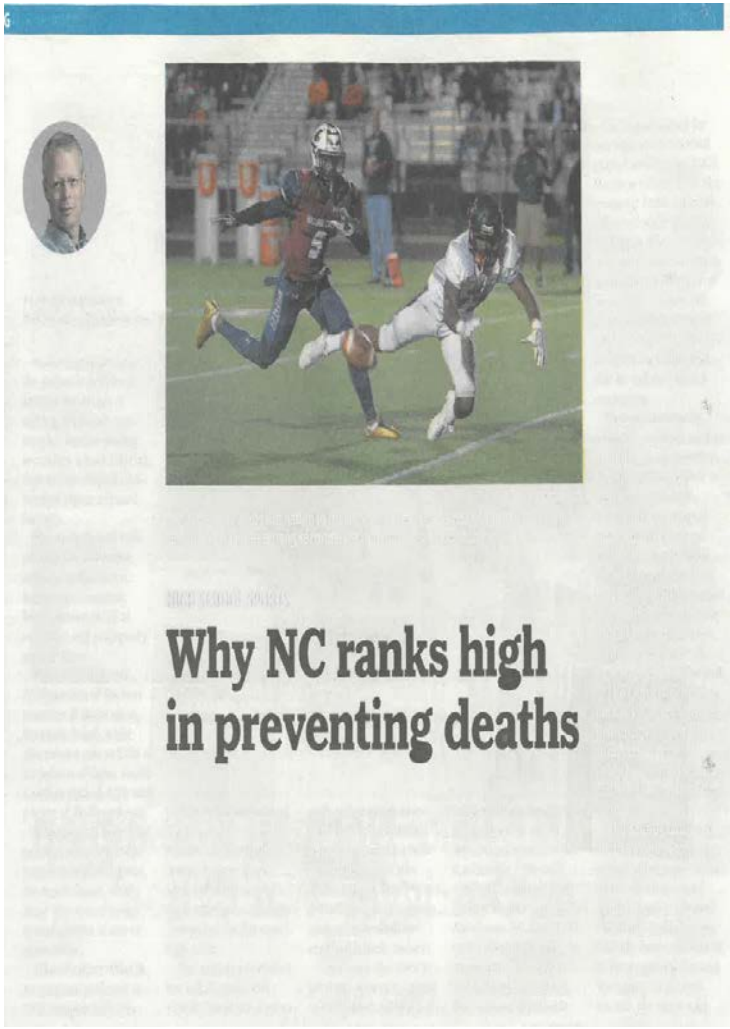
Contact, Extreme or Highly Competitive Sports

Case Example

- 35 y.o. female
- Applying for $500,000
- History of MVA six months earlier with brief loss of consciousness
- Nurse, working night shifts
- Current symptoms: foggy at the end of her shifts, otherwise no other neurologic issues
- Her doctor thought this might be post-concussion syndrome and wrote a note requesting she be taken off night shifts

Prevention

- August 30, 2017 article in *Charlotte Observer* re: high school student athletes
- NC first in nation with policies to prevent:
  - Sudden cardiac arrest
  - Heat stroke
  - **Traumatic head injuries**
- Provides
  - Medical coverage
  - Emergency preparedness
- Gfeller-Waller Concussion Awareness Act 2011
  - Two HS football players died in 2008
  - Created concussion safety training program
  - Set response standards



Diagnosis

Diagnosis

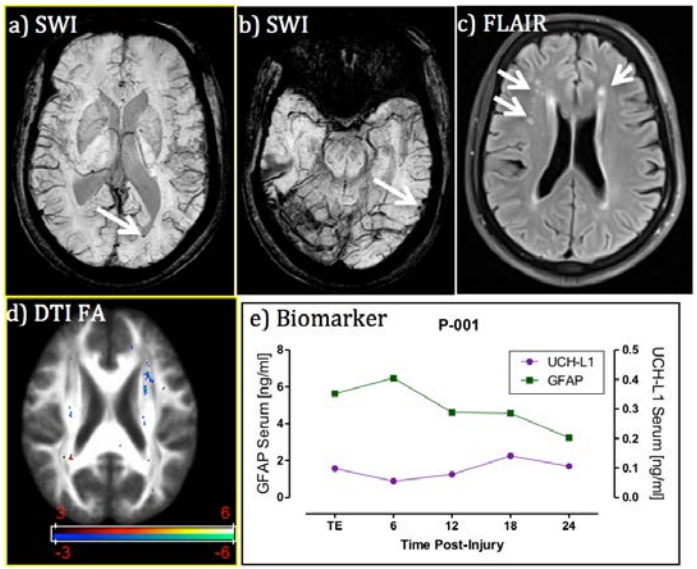
- Neurological exam
- Brain and spinal imaging: CT, CAT, MRI, SPECT, PET, EEG, etc.
- Intracranial pressure monitor for brain tissue swelling
- Patient questioning to gauge severity of injury
- Glasgow Coma Scale (scores 3 to 15)

Glasgow Coma Scale

BEHAVIOR	RESPONSE	SCORE
Eye opening response	Spontaneously	4
	To speech	3
	To pain	2
	No response	1
Best verbal response	Oriented to time, place, and person	5
	Confused	4
	Inappropriate words	3
	Incomprehensible sounds	2
	No response	1
Best motor response	Obeys commands	6
	Moves to localized pain	5
	Flexion withdrawal from pain	4
	Abnormal flexion (decorticate)	3
	Abnormal extension (decerebrate)	2
	No response	1
Total score:	*Best response*	15
	Comatose client	8 or less
	Totally unresponsive	3

Blood Test to Detect Brain Bleeds

- February 14, 2018 *New York Times* report
- FDA approved the Banyan Brain Trauma Indicator, a blood test to detect bleeding in the brain
  - Measures levels of proteins UCH-L1 and GFAP released within 12 hours of injury
  - Detects brain bleeds in people more quickly than other methods
  - Identifies possible brain injuries to brain tissues or intracranial lesions
  - Reduces exposure to radiation through CT scans
- Worked closely with DoD for wounded soldiers
- 2,000-person clinical trial financed by Pentagon led to test approval in less than six months
- Approved for use in adults at this point
- Banyan plans to start a clinical trial on injured children soon



Symptoms and Classification

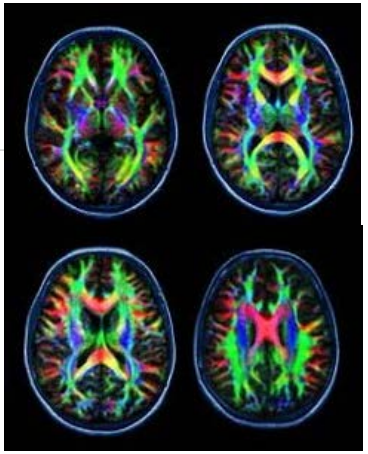
Symptoms

Cognitive 	• Confusion • Amnesia • Seizures • Difficulty concentrating	• Memory loss • Foggy or hazy feeling • Difficulty with thinking clearly
Physical 	• Headache • Nausea • Slurred speech • Impaired voice • Blurry vision • Light sensitivity	• Vomiting • Chronic pain • Paralysis or spasticity • Diminished sense of touch, taste, smell or hearing
Emotional 	• Irritability • Anxiety • Apathy • Nervousness	• Not feeling right • Depression • Loneliness
Sleep 	• More than usual • Less than usual	• Trouble falling or staying asleep

Classification: Mild Traumatic Brain Injuries (mTBI)

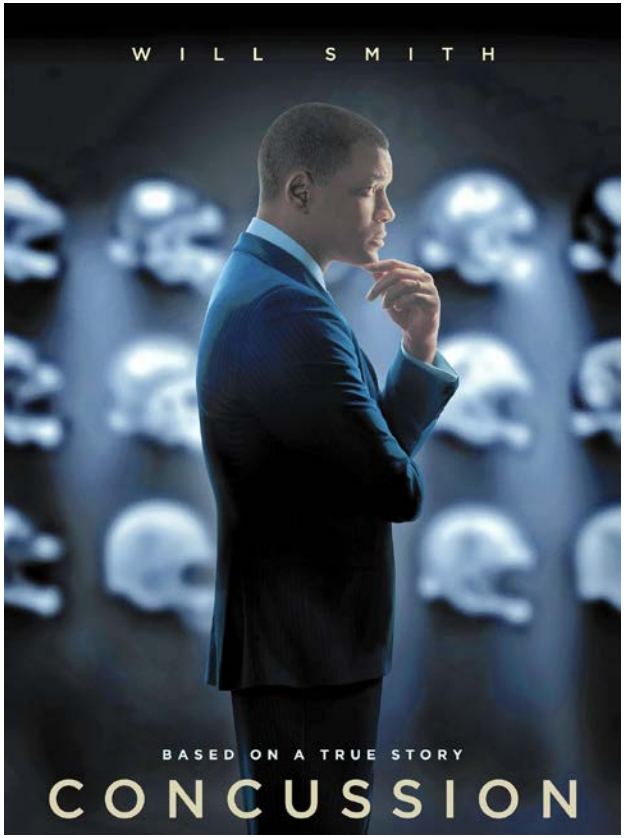
- Glasgow Coma Scale score of 13-15
- Loss of consciousness < 30 minutes
- Brain imaging often normal
- Symptoms:
  - Headache
  - Sleep cycle interruption
  - Visual disturbances
  - Easy confusion
  - Post-traumatic amnesia < 1 hour
  - Fatigue
  - Loss of balance
  - Moodiness
  - Distraction or lethargy

Mild Traumatic Brain Injuries: Concussions



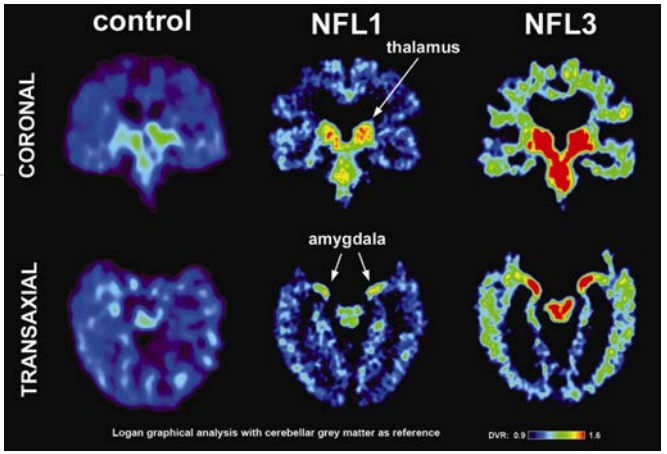
- Most frequent type of mild TBI
  - Even severe concussions are mild TBIs
- Female athletes are closing the gender gap
  - Effects of same blows are more severe
- Increased attention on effects of multiple concussions:
  - Consequences of putting an athlete with a concussion back on the field
  - Susceptible to second-impact syndrome – brain swells after second concussion before first one has been diagnosed
- More sensitive diagnostic testing such as diffusion tensor imaging
- New blood test to detect brain bleeds

2015 Film: Concussion



- Dramatic thriller based on the true David vs. Goliath story of Dr. Bennet Omalu
- Omalu is brilliant forensic neuropathologist who made the first discovery of CTE, a sports-related brain trauma
- Discovered CTE in a pro player and fought for the truth to be known
- Omalu's emotional quest put him at dangerous odds with one of the most powerful - and beloved - institutions in the world.

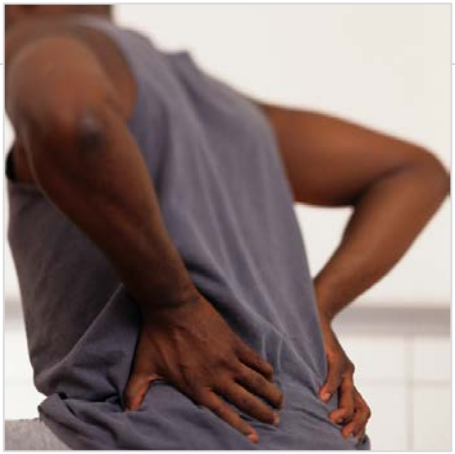
Concussions: Complications



- Second Impact Syndrome
  - Most serious complication
  - Second impact prior to symptom resolution resulting in serious brain injury
  - Vascular engorgement and/or bleed leading to massive increase in intracranial pressure, brain herniation, severe brain damage and possible death
  - Zachary Lystedt Law, Washington State 2009
- Post Concussion Syndrome
  - Persistent post-concussive symptoms lasting three months or longer
- Chronic Traumatic Encephalopathy (CTE)
  - “Punch drunk”
  - Increase mild cognitive impairment and memory issues in retired NFL players who had three or more concussions reported (NFL studies)
  - 61% reported ≥1 concussion, 24% reported ≥3 concussions

Source: Guskiewicz KM, Marshall SW, Bailes J, et al. Association between recurrent concussion and late-life cognitive impairment in retired professional football players. Neurosurgery. 2005;57(4):719–26
Image source: https://www.pbs.org/wgbh/frontline/article/new-study-finds-brain-damage-in-living-ex-nfl-players/ (credit: UCLA)

Case Example



- 37 y.o. male
- Applying for $1,000,000
- History of four concussions:
  - 5/2015 Fell and hit head, LOC 5-10 seconds, HAs and lightheadedness
  - 5/2015 Hit back of head on car, concussion and HAs
  - 8/2016 MVA, concussion and short-term memory loss, HAs, improved
  - 1/2017 Mild concussion while playing pickup basketball, confusion for a few seconds, lightheaded for 20 minutes, resolved, HAs
- Current symptoms: chronic back pain, otherwise no neurologic issues

Concussions: Mortality

- No mortality implication from a single simple concussion
- Second Impact Syndrome may have mortality implications
- No good long term studies
  - No objective diagnosis of concussion
  - Awareness has changed over the years
- NFL Study published in *Neurology*, 2012
  - Mortality study of NFL players who played at least 5 seasons 1959-1988
  - Overall, player mortality is less than expected (SMR 0.53)
  - Neurodegenerative mortality was increased (SMR 2.83)
- ALS (SMR 4.31)
- Alzheimer's Disease (SMR 3.86)

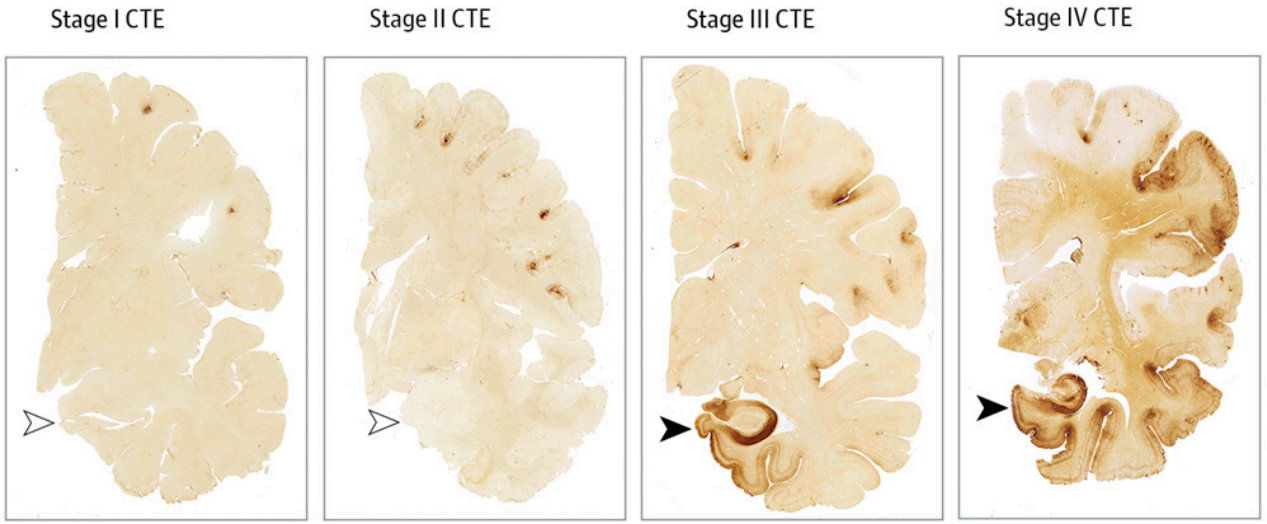
Lehman EJ, Hein MJ, Baron SL, Gersic CM. Neurodegenerative causes of death among retired National Football League players. *Neurology*. 2012;79(19):1970-1974.

Parkinson's Disease Risk Increases with TBI

- Results of new Chronic Effects of Neurotrauma Consortium Study published April 18, 2018 in *Neurology*
  – Covered October 2002 to September 2014, ages 18 and up
- **Objective:** Assess risk of Parkinson Disease (PD) following TBI (including mild TBI) at Veterans Health Administration (VHA)
- **Conclusion:** Among veterans, mild TBI is associated with 56% increased risk of PD after adjusting for demographics and medical/psychiatric comorbidities
- **Further actions:** Importance of TBI prevention, long-term follow-up, determine mechanisms and modifiable risk factors for post-TBI PD

Chronic Traumatic Encephalopathy (CTE)

- Chronic Traumatic Encephalopathy (CTE) definition: “degeneration likely caused by repeated head traumas; a diagnosis only made at autopsy” (Mayo)
- *JAMA* – 2017 report on CTE:
  - 99% NFL players found to have it
  - 87% of football players at various levels of play have it



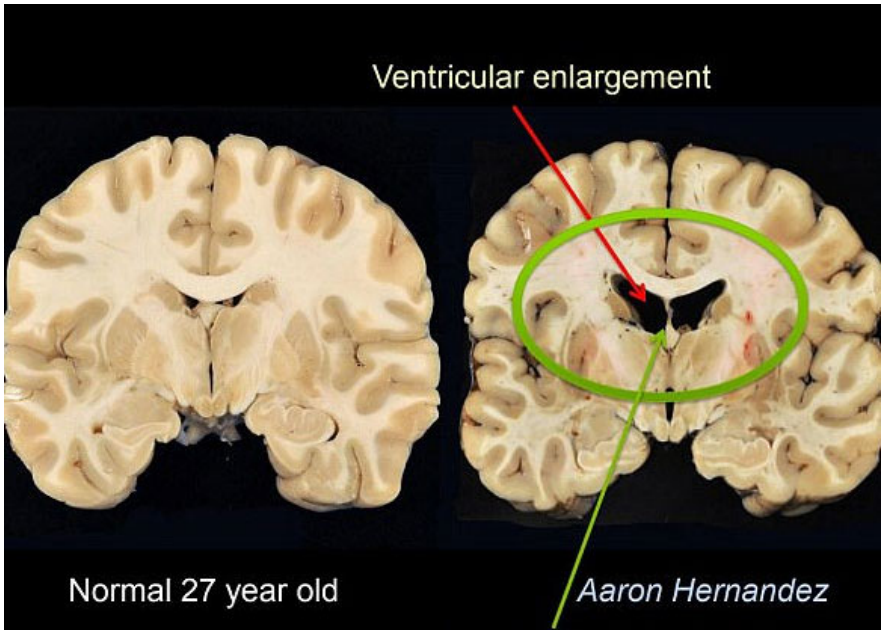
Mez J, Daneshvar DH, Kiernan PT, et al. Clinicopathological Evaluation of Chronic Traumatic Encephalopathy in Players of American Football. *JAMA.* 2017;318(4):360–370. doi:10.1001/jama.2017.8334

CTE in Aaron Hernandez

- NFL player for the Patriots
- 2013 murder conviction of Odin Lloyd
  Acquitted of two other murders
- 2017: hanged himself in prison, age 27
- Researchers found 3rd stage CTE, one of the most severe cases ever seen in someone his age.
- Usually not found in ages under 40
- Neuropathologist speculates
  - CTE correlates to the # of hits and concussions
  - Lack of impulse control from buildup of tau protein
  - Aggressive behavior, anger and rage attacks
  - Difficulty with decision making

Aaron Hernandez (#81) was an American football tight end in the NFL for three seasons with the New England Patriots. He lost his helmet during this play against the New York Jets in 2011.

CTE in Aaron Hernandez



Aaron Hernandez' brain donated to Boston University's CTE Center

Findings:

- Severe tissue damage
- Micro-bleeding
- Caused by impacts to head

202 brains from football players showed CTE in

- 99% of NFL brains
- 91% NCAA brains

Repeated Hits to the Head May Cause CTE

- *Brain* published new research study on January 18, 2018
- Seven years with researchers from Boston University, Cleveland Clinic, Harvard Medical School, Lawrence Livermore National Laboratory in California, Ben-Gurion University of the Negev in Israel and Oxford University U.K.
- Repeated hits to brain without concussions cause CTE
- CTE starts faster and earlier than previously recognized
- Evidence in animals even after one hit

Repeated Hits to the Head May Cause CTE

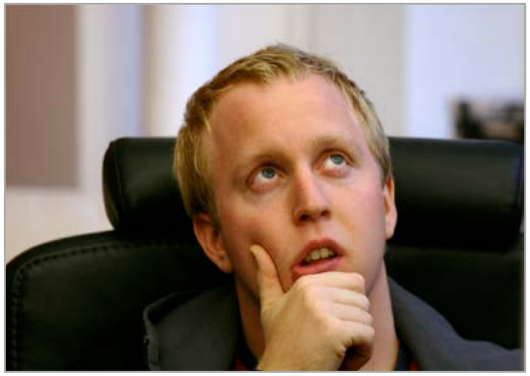
- Abnormal accumulation of tau protein
- Around small blood vessels in the brain
- Even without symptoms associated with concussions
- Silent injury – injured are not getting help
- Can cause brain cell death, cognitive deficits and dementia

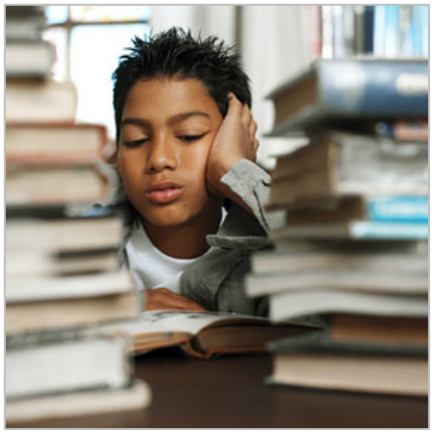
Repeated Hits to the Head May Cause CTE

- 20% of CTE cases had no record or report of concussion
- Jolts to the head trigger abnormalities even in teenagers
- Researchers studied the brains of four teenagers who died within a day to four months of a football head injury
- Compared the results to those found in mice models
- Concussion is not linked to long-term neurological disease
- NFL, NIH end concussion research with $16M unspent
- Still, concussion is part of the picture

Important Signs that the Brain Has Been Hurt

- Headaches
- Fogginess
- Concentration issues
- Memory
- Balance
- Coordination





Even without a loss of consciousness

Moderate Traumatic Brain Injuries

- Glasgow Coma Scale score of 9-12
- Loss of consciousness from 1 to 24 hours
- Brain imaging often abnormal
- Symptoms: difficulties with cognitive, speech, language, vision, sensory, social and emotional and physical changes

Severe Traumatic Brain Injuries

- Glasgow Coma Scale score of 3-8
- Loss of consciousness or coma for more than 24 hours
- Post-traumatic amnesia for more than 24 hours
- Brain imaging often abnormal
- Symptoms: difficulties with cognitive, speech, language, vision, sensory, social and emotional and physical changes

Cognitive Difficulties

- Attention
- Concentration
- Distractibility
- Memory
- Speed of processing
- Confusion
- Perseveration
- Impulsiveness
- Language Processing
- Executive functions

Perseveration definition

- Tendency of an idea to stick in the mind or recur
- Getting stuck on something mentally, not able to shift gears
- Prevent progress of thinking, persist beyond the point they are relevant
- Repetition of a particular response regardless of the absence or cessation of a stimulus
- Related to the severity of the task – the more complicated, the more chances will persevere
- Example: on being asked the name of the *previous* President the patient replies Barack Obama, on being asked the name of the *current* President the patient replies Barack Obama

Speech and Language:

- Difficulty understanding the spoken word
- Difficulty speaking and being understood
- Slurred speech
- Speaking very fast or very slowly
- Problems reading
- Problems writing

Vision

- Partial or total loss of vision
- Weakness of eye muscles and double vision
- Blurred vision
- Problems judging distance
- Involuntary eye movements
- Intolerance to light

Social and Emotional

- Dependent behaviors
- Emotional lability
- Lack of motivation
- Irritability
- Aggression
- Depression
- Disinhibition
- Denial/lack of awareness

Physical Changes

- Physical paralysis/spasticity
- Chronic pain
- Control of bowel and bladder
- Sleep disorders
- Loss of stamina
- Appetite changes
- Regulation of body temperature
- Menstrual difficulties
- Convulsions that may involve disruption in consciousness, sensory perception, or motor movements

Sensory

- Difficulties interpreting touch, temperature, movement, limb position and fine discrimination
- Loss or diminished sense of taste
- Loss or diminished sense of smell
- Decrease or loss of hearing
- Ringing in the ears
- Increased sensitivity to sounds

Case Example

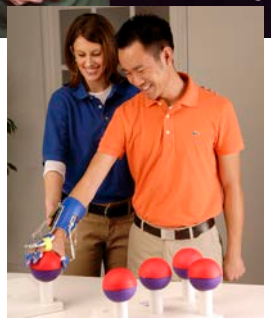
- 62 y.o. female
- Applying for $250,000
- Medical history:
  - 2013 Fell and hit back of head on ice, was starting a new business
  - No evaluation, symptoms started 5-6 months later
  - 2/2017 Short-term memory loss, irritability, inattention, intermittent confusion, repetitive story telling, symptoms come and go, don't evolve
  - Has difficulty recalling dates and repeats same info over and over
  - Is able to perform all ADLs, drives, manages all finances
  - MRI of brain, CBC, CMP, thyroid, Vitamin D, B12 and folate normal
  - Sleep disturbance, decreased concentration, agitation, anxious
  - PA: seems psychological rather than neurological, recommends neuropsychiatric evaluation, two recommended: not accepting patients
  - 3/2017 depression screen positive, normal mood and affect

Treatment

Treatment - Goals

- Mild brain injuries: non-prescription pain relievers, rest and close monitoring to prevent worsening
- Moderate to severe brain injuries:
  - Emergency intervention monitoring oxygen and blood flow to the brain
  - Prevent secondary injuries
  - Restore highest level of independence in Activities of Daily Living (ADL's)
  - Capitalize on strengths and learning new skills or strategies to compensate for deficits
  - Make accommodations to physical environment to remove barriers and enhance participation

Treatment - Types



- Therapeutic to address physical needs
  - Lab Tests
  - Medications
  - Surgery
  - Hormone therapy
- Rehabilitative to improve
  - Speech
  - Cognitive deficits
  - Behavioral deficits
  - Social/emotional deficits
- Supportive care monitoring
  - Breathing
  - Heart rhythm
  - Blood pressure
  - Pulse
  - Intracranial pressure

Treatment – a Magic Glove?

- Georgia Tech researchers Caitlyn Seim and Thad Starner have developed a pair of gloves that can:
  - Teach someone to play the piano in one hour
  - Teach a blind person to read braille in four hours instead of four months
- Gloves work through a process called passive haptic learning
- They vibrate in ways that stimulate correct movement in the user's hands
- Exploring how to restore movement in people that have suffered traumatic brain injuries
- Promising results

Treatment – Focused Approaches

- Examples from recent studies:
  - Direct attention training improves executive functioning and memory compensation strategies
  - Brain tissue oxygen monitoring
  - Medical therapies for children
  - Stem-cell based therapy
  - Dynamic pressure autoregulation strategies
  - Mnemonic studies, visual imagery training in particular improves memory
  - Monitoring sleep-wake cycles
  - Exposure screening program by DoD as complement to established programs for soldiers returning from active military zones

Prognosis and Recovery

Prognosis and Recovery

- Considerations
  - Ages 3-59 years have better prognosis than younger and older patients
  - Coma duration – the shorter the coma, the better the prognosis
  - Post-traumatic amnesia duration – the shorter, the better the prognosis
  - Imaging studies results and intracranial pressure scanning reveal extent of damage
  - With moderate to severe brain trauma, mortality higher than general population
  - Life expectancy reduced by 3-11 years for moderate to severe brain injury at older ages
  - Age, sex and severity of disability impact walking and feeding after moderate to severe TBIs
- Timeline and degree of recovery are as individualized as treatment options
  - Probabilities rather than certainties
  - Predictions are rudimentary

Underwriting Considerations

Underwriting Considerations – Life Insurance

- Type of traumatic brain injury
  - A single limited concussion with full recovery – a favorable decision may be appropriate; remember, concussions are mild TBIs
  - Minor head injuries without a skull fracture and no residuals - a favorable decision may be appropriate
- Complications
  - Multiple concussions may result in seizures or CTE even many years later
  - Major head injuries, with or without skull fractures and a loss of consciousness > 6 hours – may want to wait one year before offering
- Related impairments
  - Post-traumatic epilepsy may have a mild to moderate mortality impact if controlled, but excess mortality if seizures are frequent
  - Ongoing neurological symptoms or cognitive impairment may affect daily functioning – note ADL abilities
  - Prolonged loss of consciousness, coma or amnesia > 2 weeks – thorough review required to assess for any residual effects

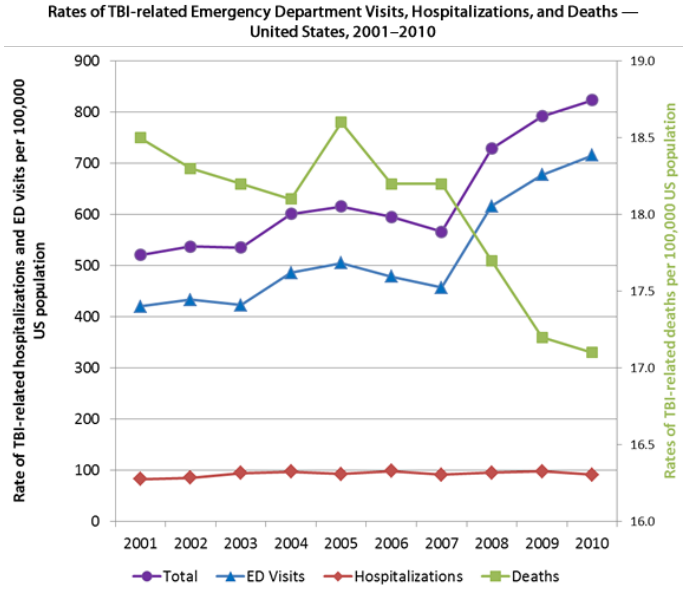
Underwriting Considerations – Disability Insurance

- More problematic for the underwriter than life insurance
- Residual effects are the primary considerations:
  - A single limited concussion with full recovery – a favorable decision may be appropriate
  - Injuries with long lasting effects such as paralysis and seizures – an unfavorable decision may be appropriate
  - Multiple surgeries needed – an unfavorable decision may be appropriate
  - Therapies including speech, physical, behavioral and occupational therapies – assess for degree of recovery
  - Full recovery may not occur – underwrite carefully
  - Exclusion riders may be a consideration depending on the product design
  - Reconsideration may be possible if full recovery is achieved

Conclusion

Conclusion

- Incidence of Traumatic Brain Injuries around the world is rising
- Multiple brain injuries, even mild concussions, may have long-term impacts
- Broad spectrum of dysfunction may result
- Residual effects may not emerge until years after incident
- The greater the likelihood of neuromorbidities
- Underwrite cautiously



Source: Centers for Disease Control
www.cdc.gov/traumaticbraininjury/data/rates.html

Useful Resources

- https://www.biausa.org
  (BIAA - Brain Injury Association of America: a national health organization dedicated to brain injury prevention, research, education and advocacy, it has branches in many states)
- www.aan.com
- www.asha.org/PRPSpecificTopic.aspx?folderid=8589935337&section=Treatment
- www.biausa.org/about-brain-injury.htm
- braintrauma.org
- www.cdc.gov/traumaticbraininjury/
- dvbic.dcoe.mil
- dx.doi.org/10.1016/j.apmr.2015.02.002
- familydoctor.org/condition/traumatic-brain-injury/?adfree=true
- https://www.scientificamerican.com/.../fda-okays-first-concussion

Useful Resources (continued)

- www.military.com/benefits/veterans-health-care/traumatic-brain-injury-symptoms-diagnosis-and-treatment.html
- www.nejm.org/doi/full/1.0.1056/NEJMp1007051
- projectreporter.nih.gov/project_info_description.cfm?aid=8644167&icde=21158616&ddparam=&ddvalue=&ddsub=&cr=1&csb=default&cs=ASC
- www.washingtonpost.com/news/morning-mix/wp/2016/04/12/40-percent-of-former-nfl-players-suffer-from-brain-damage-new-study-shows/?utm_term=.310018083c25
- http://n.neurology.org/content/early/2018/04/18/WNL.0000000000005522

Q & A

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SCOR
The Art & Science of Risk
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