



Traumatic Brain Injuries and Post-concussive Syndrome

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Presenter



Dr. Robert Hall
Corporate Medical Director

As Corporate Medical Director, Dr. Robert Hall advises our clients and employees on evidence-based clinical and rehabilitation best practices that optimize our pharmacy, home health, and durable medical equipment programs. His passion is to promote better outcomes using a holistic and patient-centered approach for the care of injured persons. Additionally, he offers counsel on our processes and procedures to help identify and reduce prescription medication misuse and abuse.

A practicing, board-certified physical medicine and rehabilitation physician, Dr. Hall has treated patients in private practice, private and state-run hospitals, and outpatient clinic settings. He has been the medical director of two acute inpatient rehabilitation centers in central Ohio. His areas of expertise include traumatic brain injury, spinal cord injury, amputation, and general rehabilitation. He is also board certified in electromyography.

After receiving his Bachelor of Science (cum laude) in Electrical Engineering at The Ohio State University, he continued with his medical school training and served as chief resident in physical medicine and rehabilitation at the university's medical center. He has been awarded the distinction of "Best Doctors in America[®]" since 2009.

Learning objectives

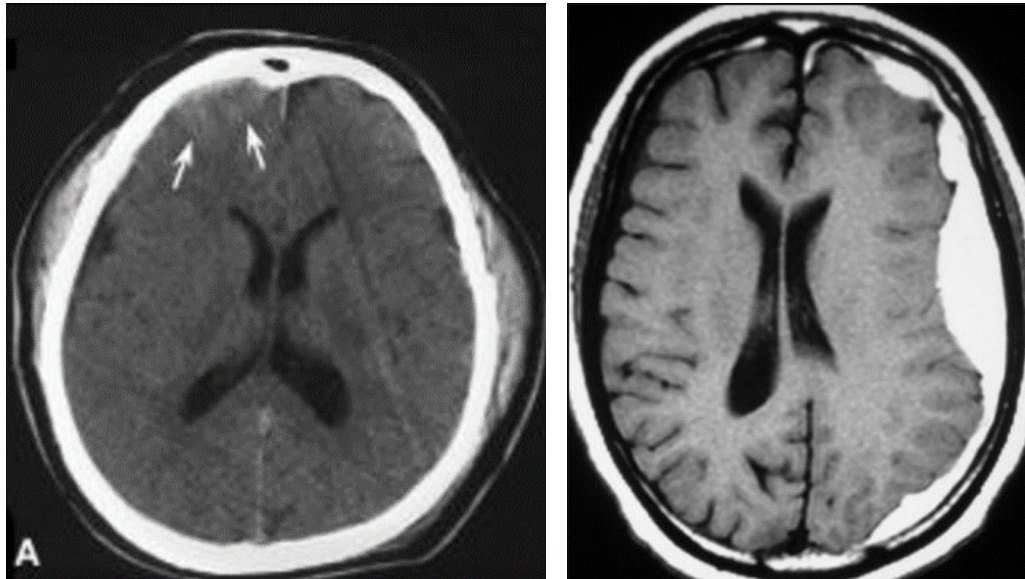
- Understand the causes and prevention of concussion and other traumatic brain injuries (TBIs).
- Discuss the classification systems and terms used to describe TBI severity.
- Understand the potential symptoms associated with TBI.
- Describe the initial evaluation of TBI and its treatment course.
- Review the discharge planning needs and long-term outcomes associated with traumatic brain injuries.
- Review the long-term outcomes associated with concussion and post-concussive syndrome.
- Discuss the latest research in the early diagnosis and treatment of concussion and other TBIs.

Causes and prevention

of concussion and other traumatic brain injuries

What is a traumatic brain injury?

- Pathophysiology
 - Primary injury: Impact, Immediate intracranial bleeding
 - Secondary injury: Swelling, Neuroinflammatory response
- Differences between traumatic and anoxic brain injuries



Causes and prevention of concussion and TBIs



Causes

- Motor vehicle accidents
- Falls
- Self-inflicted wounds
- Assault
- Sports



Prevention

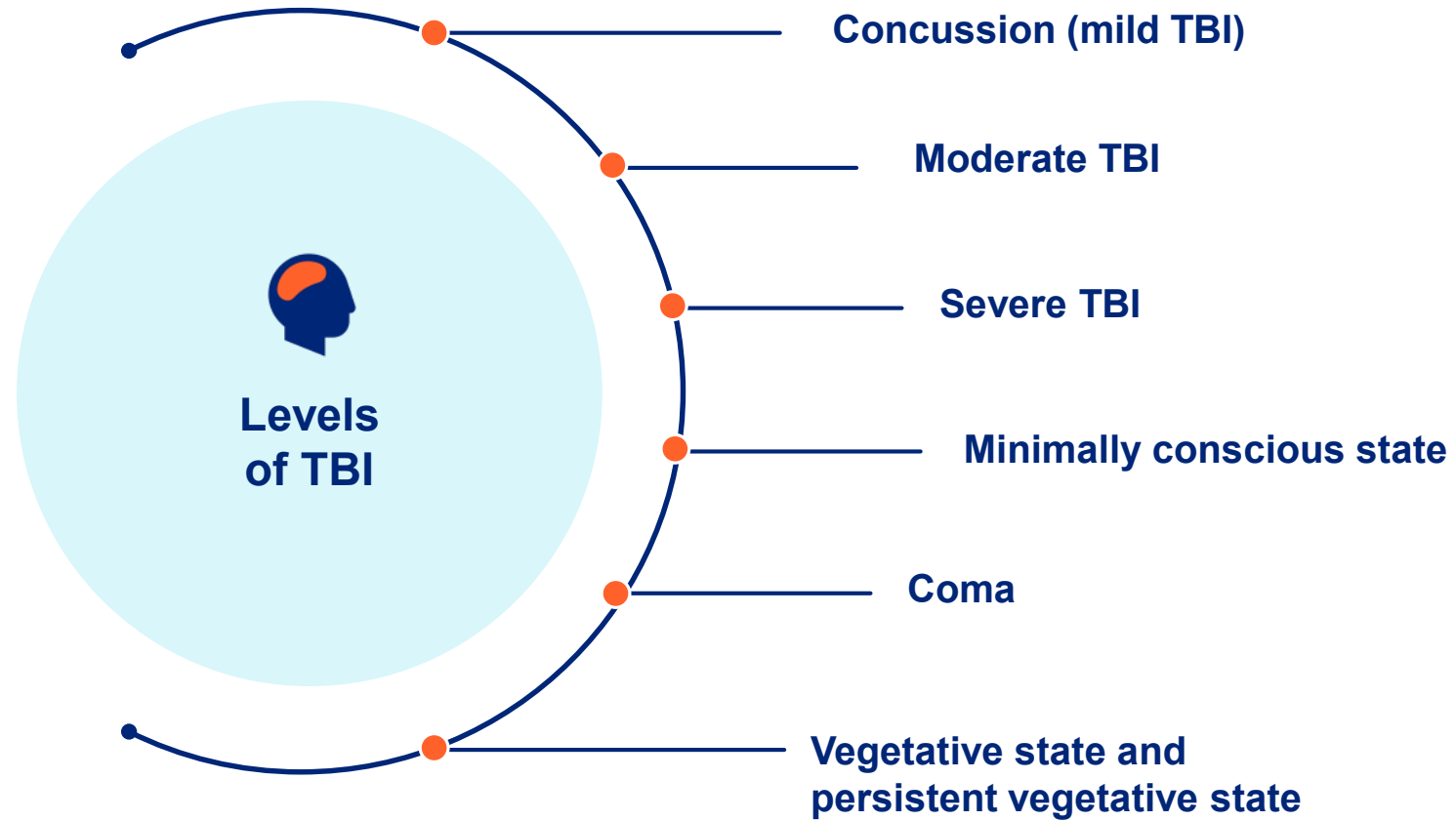
- Seat belts, air bags, not driving while intoxicated
- Harness, helmet, safe surroundings
- Early identification, psychological screening
- Safe surroundings
- Safe technique, helmet

Source: https://www.cdc.gov/traumaticbraininjury/get_the_facts.html

Classification systems and terms

to describe brain injury severity

TBI Terminology



Differences between concussions and moderate to severe TBIs

- Severity of injuries, i.e., skull fractures, intracranial hemorrhage, etc.
- Duration of symptoms
- No imaging abnormalities with concussions



Glasgow Coma Scale (GCS)

Eye Opening Response

- 4 = Spontaneous
- 3 = To verbal stimuli
- 2 = To pain
- 1 = None

Verbal Response

- 5 = Oriented
- 4 = Confused
- 3 = Inappropriate words
- 2 = Incoherent
- 1 = None

Motor Response

- 6 = Obeys commands
- 5 = Localizes pain
- 4 = Withdraws form pain
- 3 = Flexion to pain or decorticate
- 2 = Extension to pain or decerebrate
- 1 = None



Ranchos Los Amigos Scale

Level I	No response	Level V	Confused inappropriate
Level II	Generalized response	Level VI	Confused appropriate
Level III	Localized response	Level VII	Automatic appropriate
Level IV	Confused-agitated	Level VIII	Purposeful appropriate

Symptoms and abnormalities

based on type and location of brain injury

Concussion (mild TBI)

No visible abnormalities on imaging studies of the skull and brain

- Skull X-rays
- Head CT
- Brain MRI

Injury does not exceed the following

- Loss of consciousness > 30 minutes
- Post-traumatic amnesia > 24 hours

Initial GCS 13-15



Cuccurullo, Sara J. *Physical Medicine and Rehabilitation Board Review*. 3rd ed. New York: Demos Medical, 2015. Pages 94-97.

Concussion (mild TBI)

Acute signs and symptoms

- Disorientation/confusion
- Impaired balance
- Increased reaction time
- Headache (most common symptom)
- Dizziness
- Memory problems

Symptoms that may develop

- Irritability
- Sleep disturbance
- Fatigue
- Depression and/or anxiety
- Concentration problems

Cuccurullo, Sara J. *Physical Medicine and Rehabilitation Board Review*. 3rd ed. New York: Demos Medical, 2015. Pages 94-97.

Concussion (mild TBI) severity

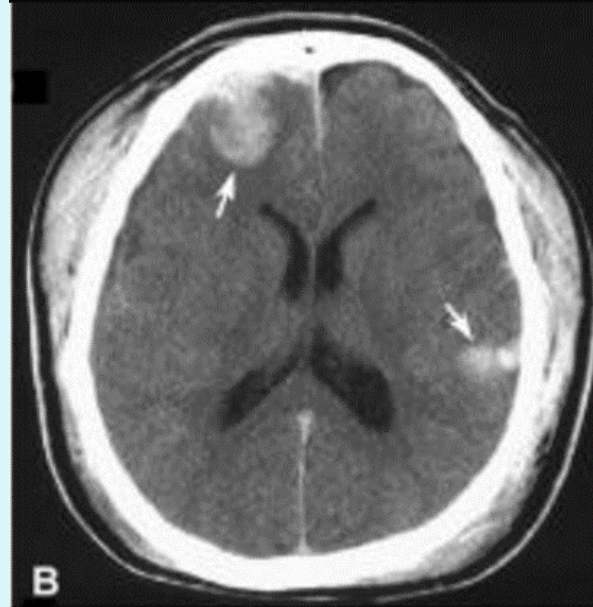
	Grade 1 (Mild)	Grade 2 (Moderate)	Grade 3 (Severe)
Loss of consciousness	No	<1 minute	> 1 minute
Posttraumatic amnesia	<30 minutes	30 minutes to 24 hours	> 24 hours
Symptoms	< 30 minutes	30 minutes to 7 days	>7 days

Cuccurullo, Sara J. *Physical Medicine and Rehabilitation Board Review*. 3rd ed. New York: Demos Medical, 2015. Pages 94-97.

Other types of traumatic brain injuries



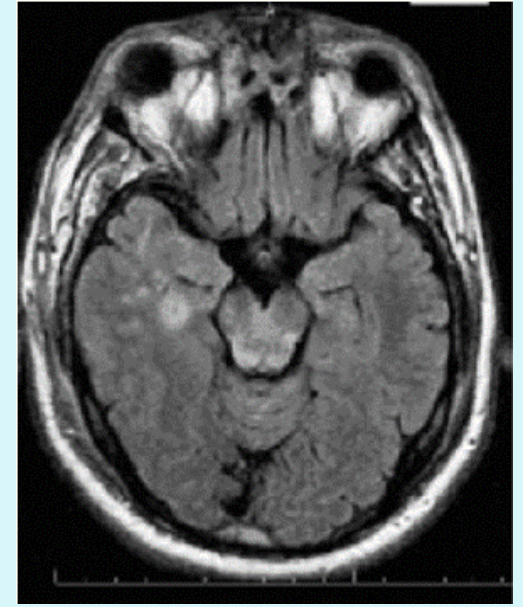
Penetrating injuries



Cerebral or cortical contusions



Intracranial hemorrhage



Diffuse axonal injury

Penetrating injuries to the brain

Symptoms and abnormalities

- Focal neurologic deficits
- Speech/language abnormalities
- Muscle weakness
- Risk of infection, bleeding and swelling

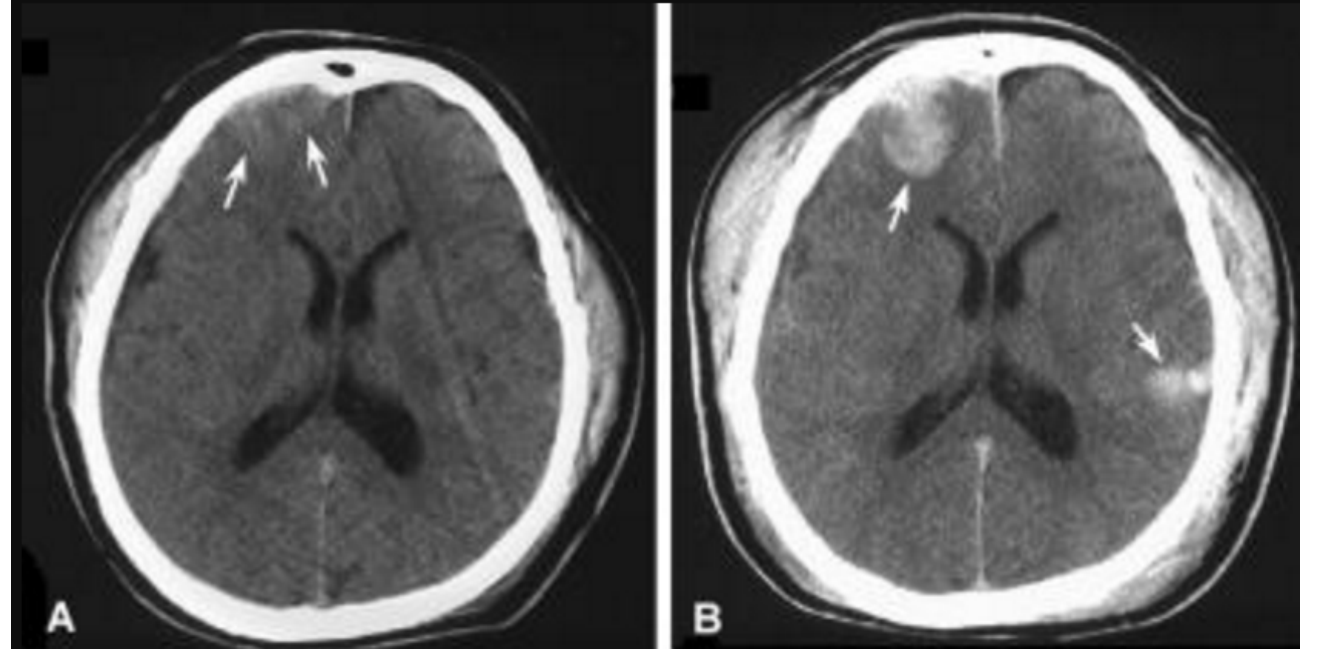


Source: http://www.onlinejets.org/viewimage.asp?img=JEmergTraumaShock_2011_4_3_395_83871_f2.jpg

Cerebral or cortical contusions

Symptoms and abnormalities

- Headache
- Nausea and vomiting
- Confusion and memory loss
- Personality changes



Source: <http://img.medscapestatic.com/pi/meds/ckb/97/15097tn.jpg>

Intracranial hemorrhage

Symptoms and abnormalities

- Severe headache
- Sudden weakness
- Vision and balance difficulties



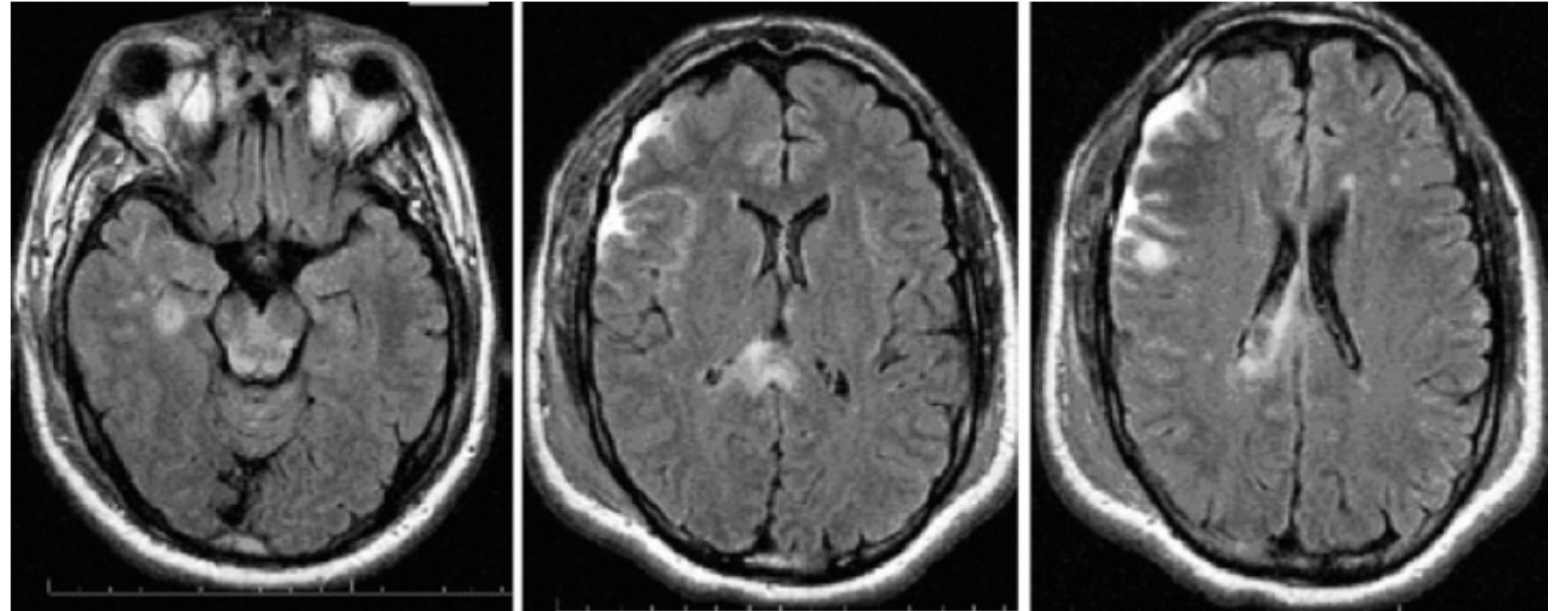
Source:

1. <http://img.medscapestatic.com/pi/meds/ckb/60/37860tn.jpg>
2. <http://img.medscapestatic.com/pi/meds/ckb/94/15794tn.jpg>

Diffuse axonal injury

Symptoms and abnormalities

- Decreased level of consciousness
- Unconsciousness
- Vegetative state



Source: http://www.sciencedirect.com/topics/page/Diffuse_axonal_injury

Initial evaluation and treatment

of concussion and traumatic brain injuries

Immediate and life-saving interventions

Assess responsiveness

- Level of consciousness
- Memory
- Cognition
- Command following

ABCs

- Airway
- Breathing
- Circulation

Intracranial pressure

Other injuries

Diagnostic studies

X-ray

Skull fracture

Head CT

Intracranial hemorrhage

Brain MRI

Diffuse axonal injury

Other injuries

- Other fractures (arms, legs, ribs, spine, etc.)
- Organ injury (heart, lung, liver, spleen, kidney, etc.)
- Spinal cord injury

Acute hospitalization

Concussions/mild TBI

- Emergency room/urgent care evaluation
- Hospitalization not usually required

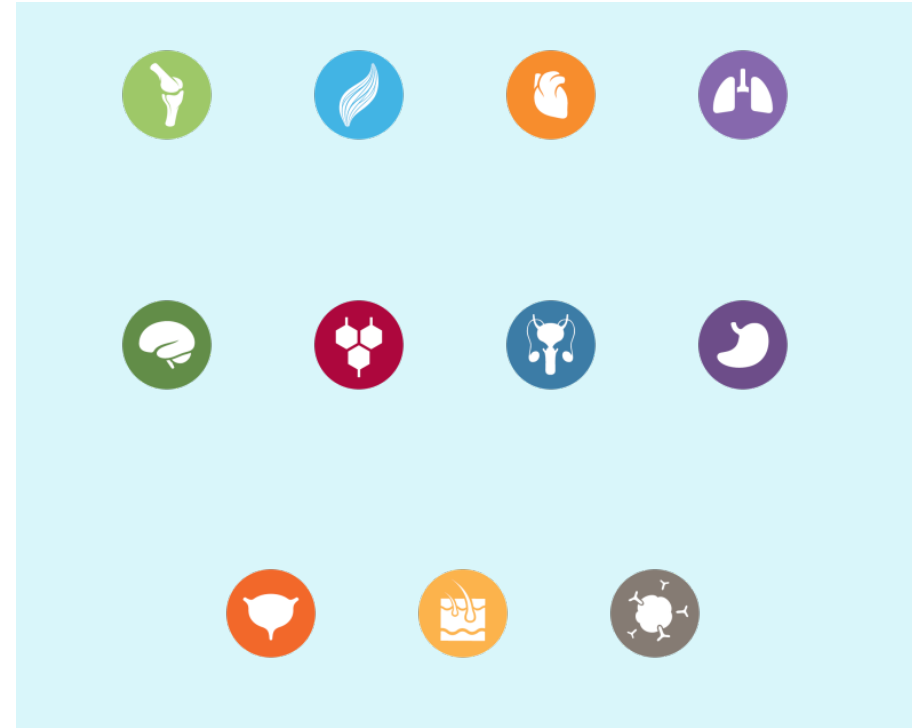
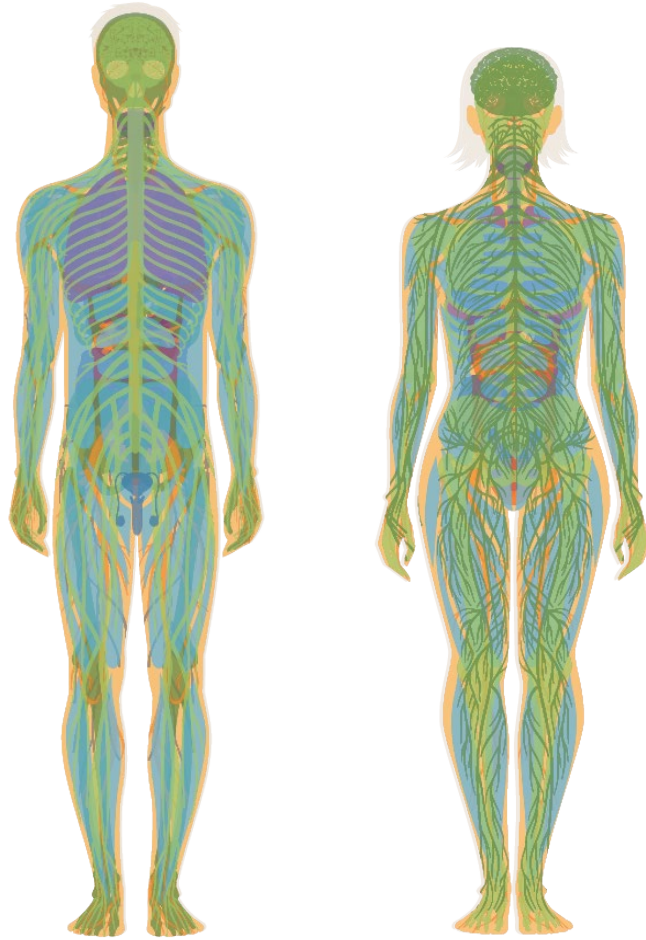
Moderate to severe TBI

- Hospitalization
- Sedation
- Agitation control
- Seizure management
- Pain relief
- Mechanical ventilation
- Surgery



Impact on the body systems

Traumatic brain injuries can affect every major body system

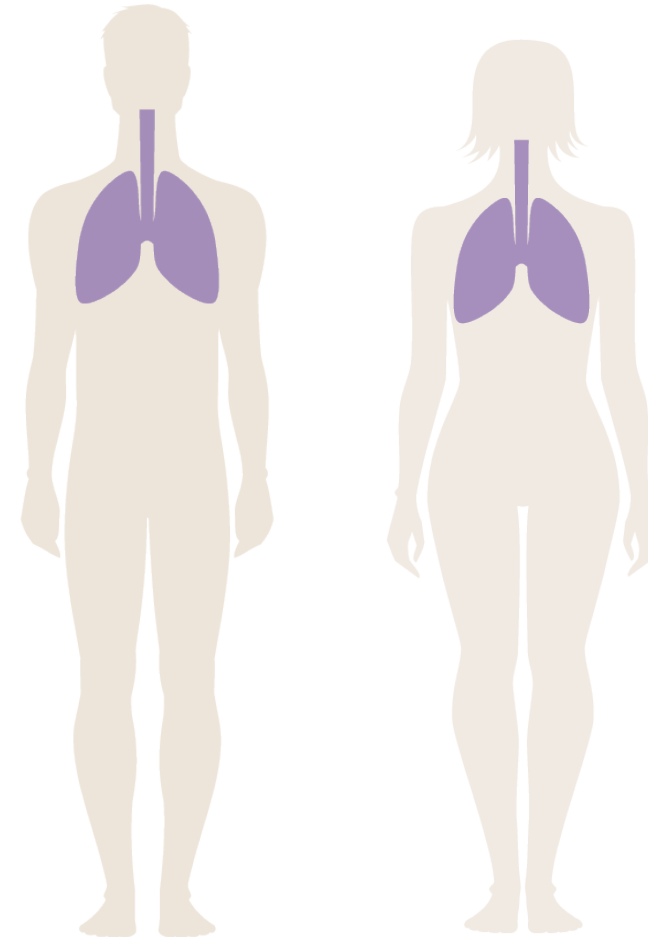


Respiratory system

- Atelectasis
- Pneumonia
 - Aspiration
- Respiratory failure
 - Mechanism
 - Treatments
 - Mechanical ventilation
 - Tracheostomy
- DVT/PE

Medications

- Antibiotics
- Anticoagulants

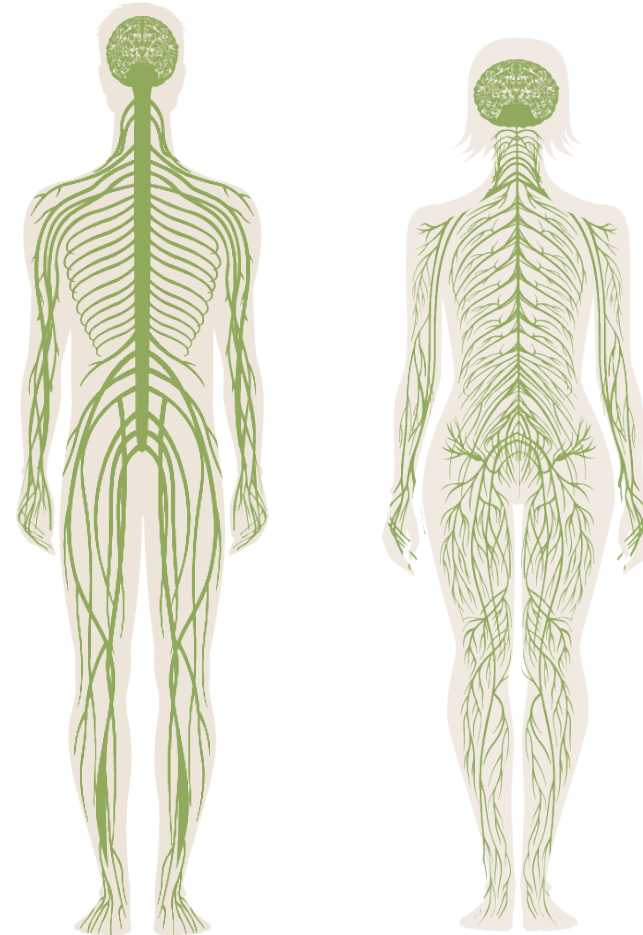


Nervous system

- Post-traumatic seizures
- Hydrocephalus
- Decreased arousal
- Dysautonomia
- Agitation

Medications

- Anticonvulsants
- Blood pressure medications
- Stimulants
- Antipsychotics

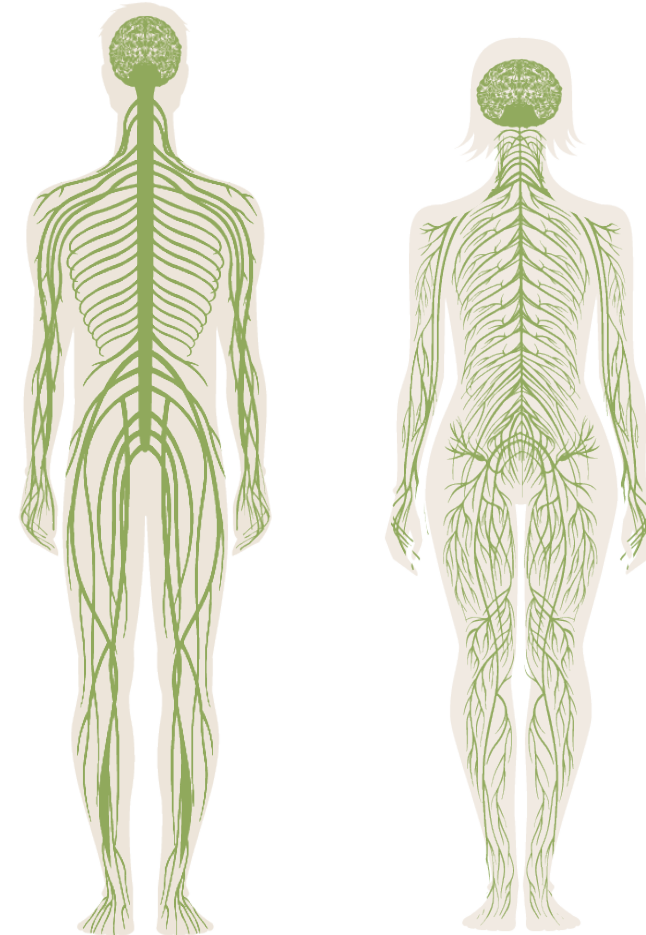


Nervous system

- Cognitive impairments
 - Personality changes
 - Impulsivity
 - Impaired attention and concentration
 - Decreased memory (Post-traumatic amnesia)
- Psychological impact
 - Depression and anxiety
- Sleeping disorders
- Vision loss and inability to smell

Medications

- Anticonvulsants, stimulants and sedatives
- AChE inhibitors (e.g., donepezil)
- Antidepressants and anxiolytics

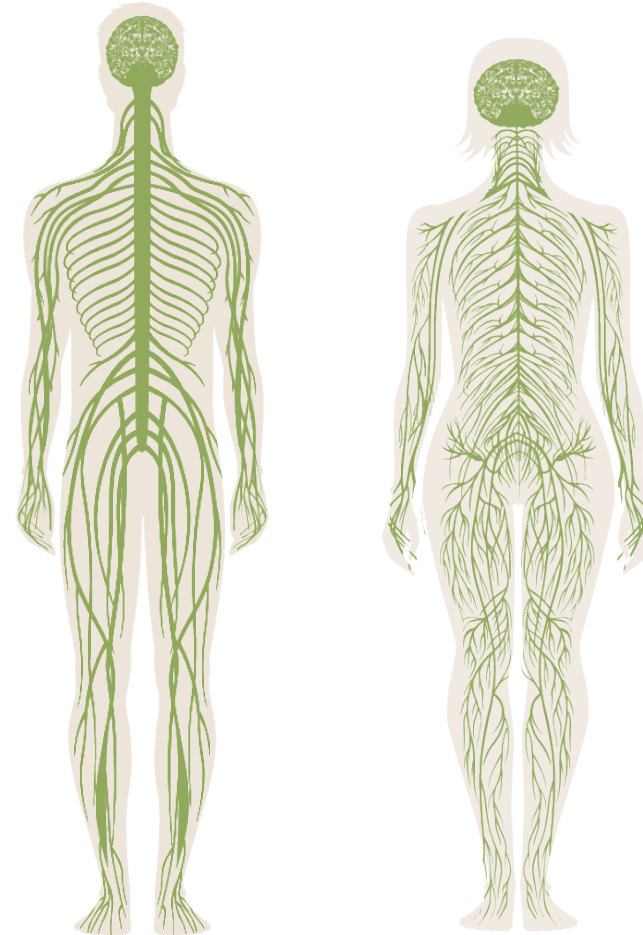


Nervous system

- Weakness
 - Brain injury
 - Spinal cord injury
 - Peripheral nerve injury
 - Fracture
- Pain
 - Orthopedic
 - Central
 - Visceral

Medications

- Analgesics
- Antidepressants and anticonvulsants

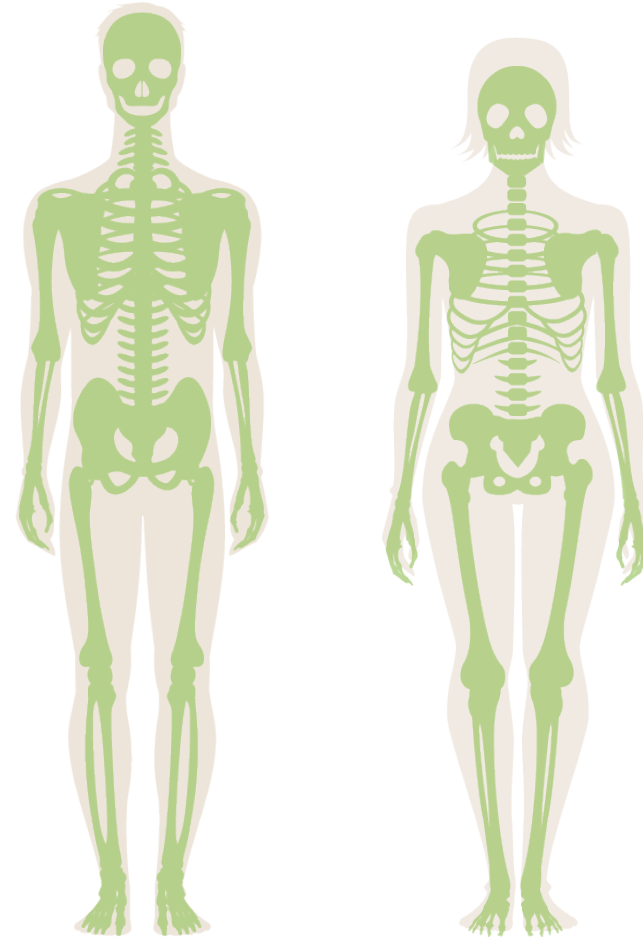


Skeletal system

- Risk of falls and fractures
- Heterotopic ossification

Medications

- Anti-inflammatories
- Etidronate

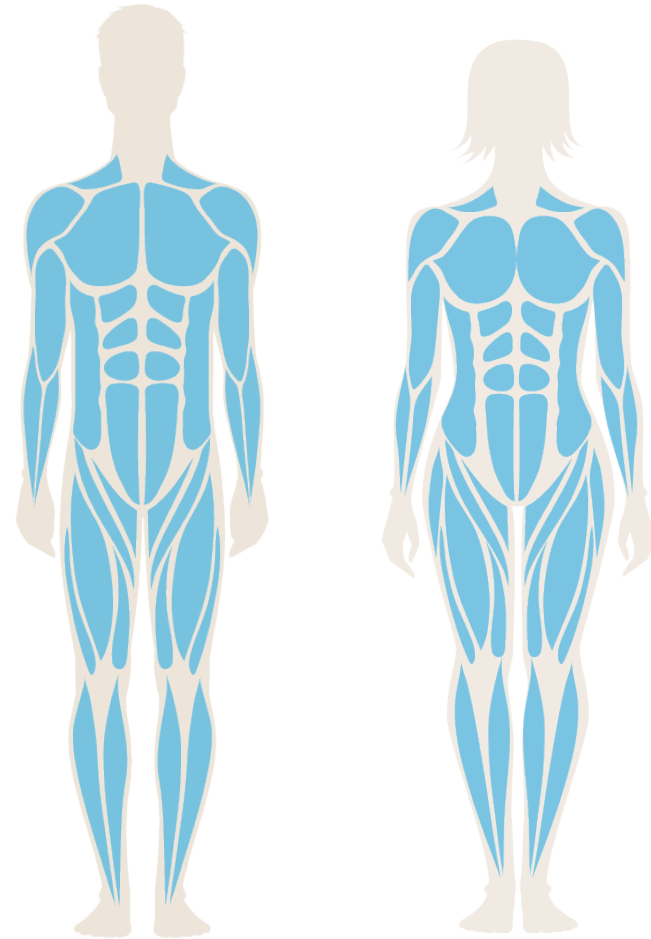


Muscular system

- Spasticity
- Contractures
- Atrophy
- Debility and deconditioning

Medications

- Muscle relaxants
- Botulinum toxin
- Intrathecal baclofen pump

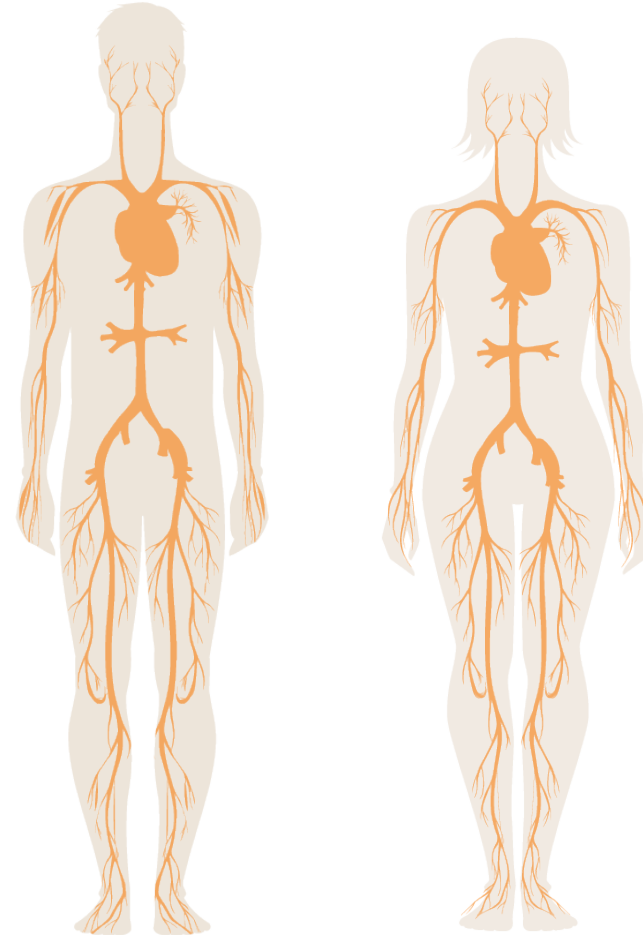


Cardiovascular system

- Increased risk of heart disease
- Elevated cholesterol
- Decreased HDL
- Increased blood glucose levels

Medications

- Blood pressure medications
- Cholesterol and diabetes medications

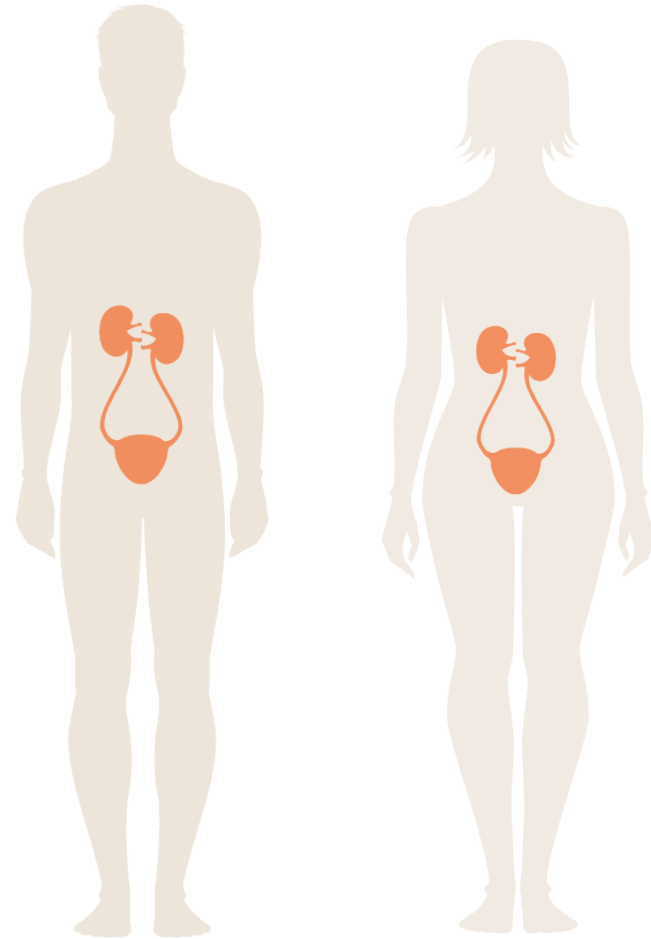


Urinary system

- Incontinence
- Retention

Medications

- Oxybutynin
- Tamsulosin

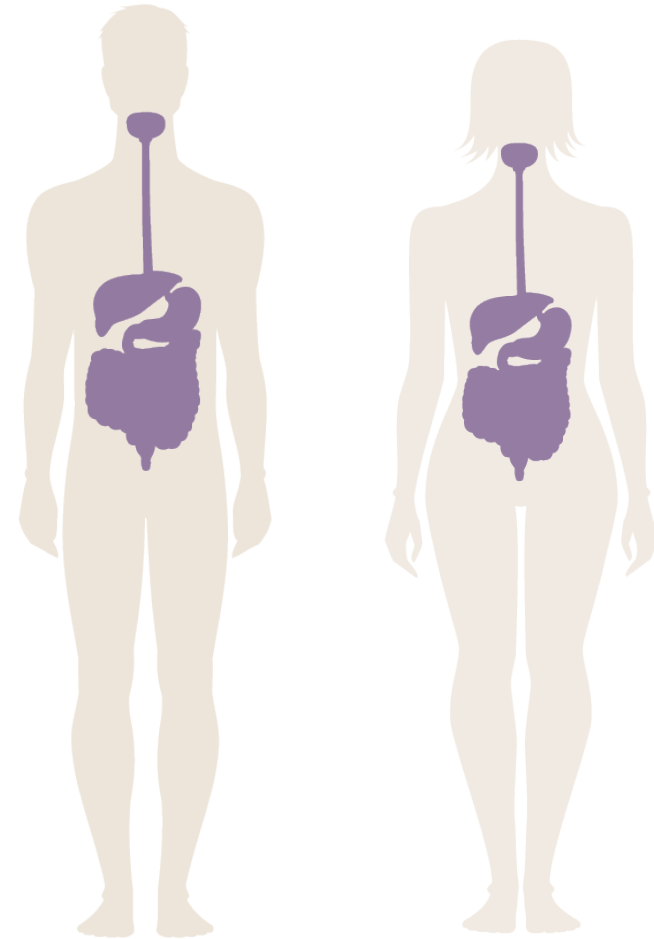


Digestive system

- Incontinence
- Constipation
- Dysphagia

Medications

- Stool softeners
- Laxatives
- Fiber

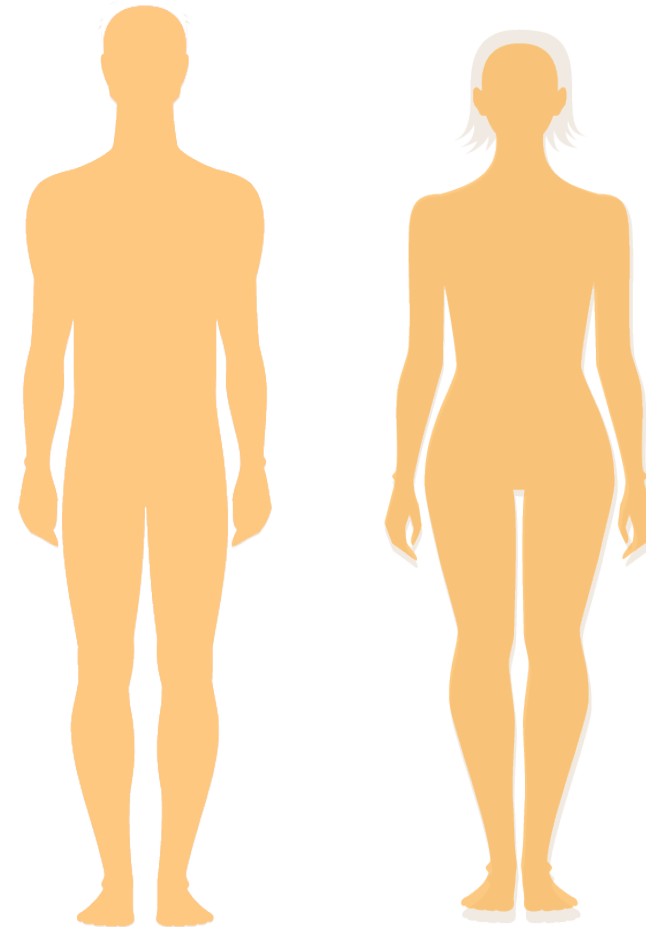


Integumentary system

- Pressure wounds
- Healing injury or surgical wounds

Medications

- Topical skin protectants
- Antibiotics



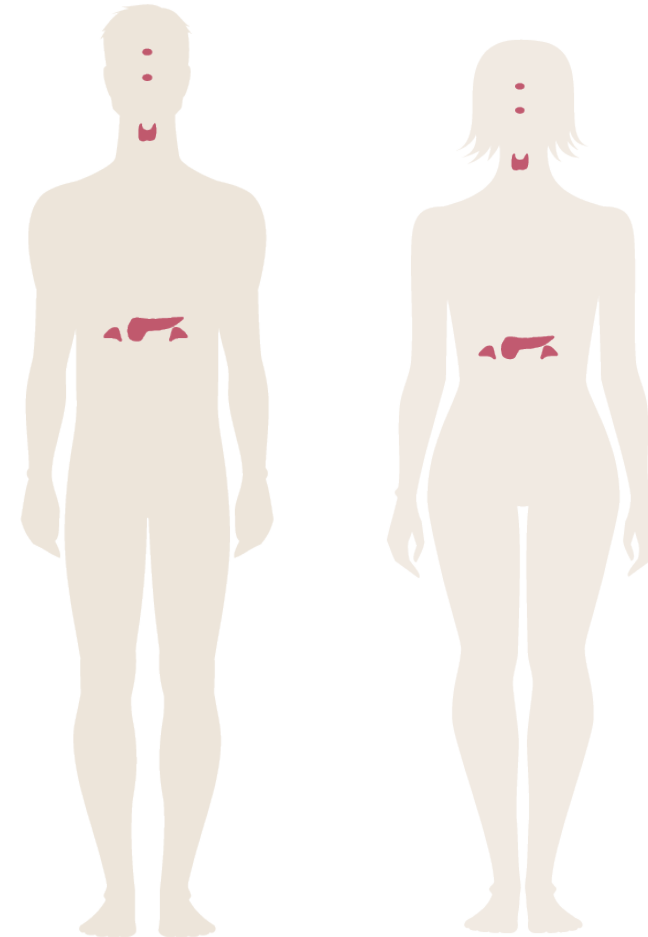
Endocrine system

Pituitary injury

- Growth hormone deficiency
- Syndrome of inappropriate antidiuretic hormone (SIADH)
- Cerebral salt wasting
- Diabetes insipidus
- Other hormonal abnormalities

Medications

- Hormone replacement
- DDVAP
- Demeclocycline
- Hydrocortisone



Reproductive system

Sexual dysfunction

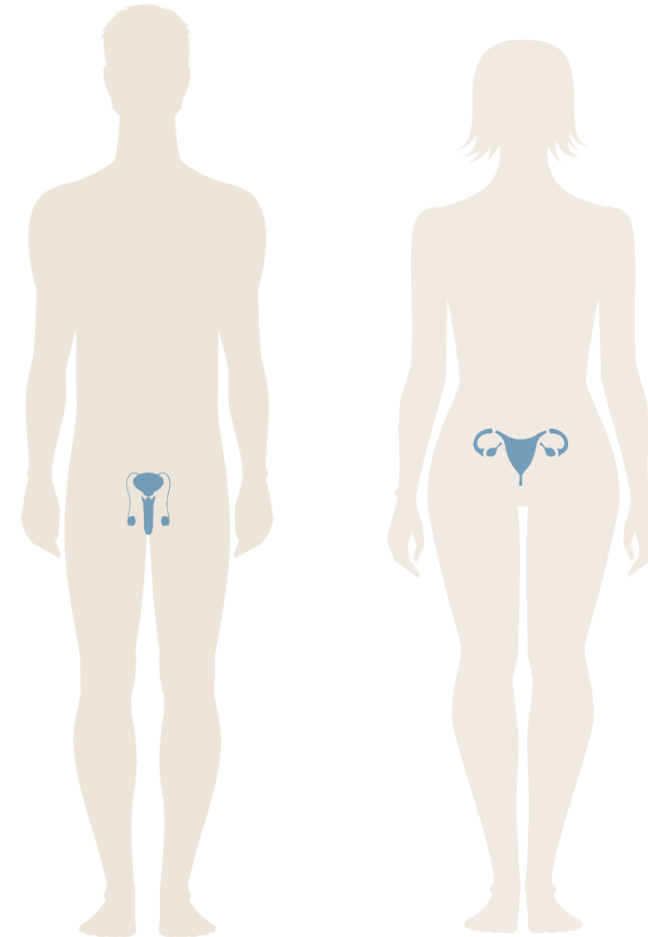
- Libido
- Strained relationships

Risks for unsafe sexual activity

- Behavioral
- Impulsivity
- Impaired decision making
- Pregnancy

Medications

- Hormone replacement therapy
- Birth control

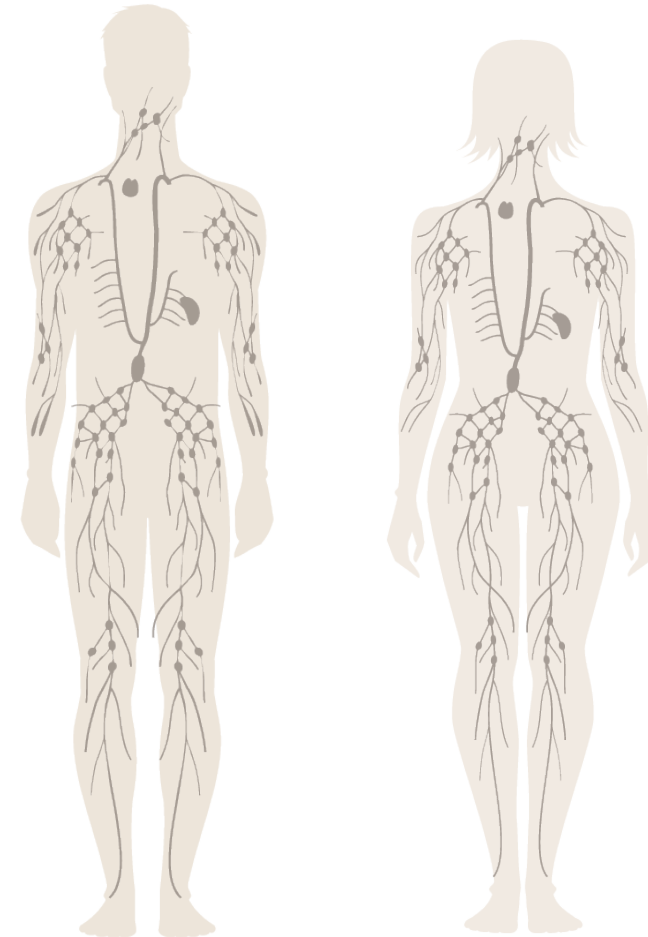


Immune system

- Systemic immune suppression
- Infection risks
- Evaluation of fever

Medications

- Antibiotics



Source:

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4633482/>

2. <http://www.vglifesciences.com/2015/stunning-discovery-showing-lymphatic-system-in-the-brain-illuminates-vg-life-sciences-traumatic-brain-injury-research/>

Brain injury treatment

Recommended treatment for concussion



Physical and cognitive rest with limited activity of the following

- Television
- Computer
- Video games
- Cognitively demanding work

Symptom management



Non-pharmacologic

- Counseling
- Education (patient and family)



Pharmacologic

- Antidepressants
- Non-opioid analgesics (acetaminophen)

Patients and family members should

- Monitor for post-concussive symptoms, which may not occur until days later
- Getting plenty of rest and sleep to help the brain heal
- Gradually return to their usual routine only after patients start to feel better

Source: https://www.cdc.gov/traumaticbraininjury/pdf/tbi_clinicians_factsheet-a.pdf

How long should a patient rest after concussion

- Patient-specific
- Avoid excessive rest if not indicated

Resuming activities encouraged as long as they do not

- Worsen concussion symptoms
- Increase the risk for another concussion



Immediately after concussion

As much rest as possible



24 hours after concussion

- Relative rest
- Avoiding activities (physical and mental) that worsen concussion symptoms



Symptoms stabilized and improving

- Gradual return to activity
- Monitoring and adjust for worsening symptoms

<https://www.psychologytoday.com/us/blog/brain-trauma/201612/rest-or-no-rest-after-concussion>

Treatment for moderate to severe TBIs

- Medical stabilization
- Acute inpatient rehabilitation
 - Interdisciplinary
 - Secure units vs. restraints
 - Family training
 - Length of stay
 - Functional recovery



Discharge planning

- Follow-up providers
- Medications (including administration)
- Nutrition
- Durable medical equipment (DME)
- Transportation
- Home modifications
- Rehabilitation
- Neuropsychology
- Safety
- Vocational



Equipment and modifications



Mobility equipment

(i.e., medical devices, DME)

- Cane/walker
- Bracing
- Wheelchairs
 - Manual
 - Power
 - Safety considerations with cognition impairment
 - PT or OT + physician evaluation



Home modifications

- Ramp
- Widening of doorways
- Safety considerations



Community re-entry

- Driving
 - Return to driving programs
 - Vehicle modifications
 - Transport vans
- Vocational
- Recreational

Post-discharge rehabilitation

- Memory
- Attention
- Problem solving
- Speech and swallow
- Range of motion
- Strengthening
- Balance
- Coordination
- Ambulation
- Community reintegration
- Vocational



The new normal

- Ongoing safety needs
- Community reintegration
- Psychological support and counseling
- Long-term medication and therapy requirements



Post-concussive syndrome

Post-concussive syndrome (PCS) symptoms

- Headache
- Dizziness
- Fatigue
- Irritability
- Impaired memory, attention, concentration and learning
- Insomnia
- Decreased tolerance to noise and light



Diagnosis of PCS

- Symptoms and their duration
 - Presence of at least three symptoms
 - Symptoms appearing within the first week after injury
 - Symptoms persisting for several weeks to three months after injury
- Greater duration of LOC or PTA makes likelihood of PCS greater
- 50% of patients at one month and 15% of patients at one year
- Greater in females than in males
- Increasing age is a risk factor
- Worse with dizziness and continued pain
- Persistent post-concussive syndrome (PPCS)
 - More prolonged symptoms
 - Six months to more than one year

Distinguishing PCS from other comorbidities

- Depression
- Posttraumatic stress disorder
- Substance abuse
- Suicidality

<https://www.healthquality.va.gov/guidelines/Rehab/mtbi/mTBICPGClinicianSummary50821816.pdf>

Treatment of PCS



Pharmacologic

- Non-opioid analgesics for headaches
- Avoid overuse of over-the-counter headache medicines
- Anticonvulsants
- Antidepressants
- Beta blockers (anti-hypertensive medications)
- Anti-emetics for nausea
- Antidepressants and anxiolytics for mood disturbance



Non-pharmacologic

- Education
- Limited cognitive rest
- Psychological counseling
- Neurocognitive testing and treatment
- Cognitive behavioral therapy
- Symptom specific treatments
- Vestibular rehabilitation
- Physical therapy
- Vision therapy

Prognosis of post-concussive syndrome

Post-concussion symptom scale (PCSS)

- Initial symptom burden
- Symptoms ranked 1 from 6 by severity
- 86% of patients with PCSS < 13 had their symptoms resolve within 28 days
- 65% of patients with PCSS of ≥ 13 had prolonged symptoms

Most concussions resolve in one week

95% recover in three to twelve months

Name: _____ Age/DOB: _____ Date of Injury: _____

Post Concussion Symptom Scale

No symptoms "0" ----- Moderate "3" ----- Severe "6"

Time after Concussion

<u>SYMPTOMS</u>	Days/Hrs _____	Days/Hrs _____	Days/Hrs _____
Headache	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Nausea	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Vomiting	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Balance problems	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Dizziness	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Fatigue	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Trouble falling to sleep	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Excessive sleep	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Loss of sleep	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Drowsiness	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Light sensitivity	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Noise sensitivity	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Irritability	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Sadness	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Nervousness	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
More emotional	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Numbness	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Feeling "slow"	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Feeling "foggy"	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Difficulty concentrating	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Difficulty remembering	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
Visual problems	0 1 2 3 4 5 6	0 1 2 3 4 5 6	0 1 2 3 4 5 6
TOTAL SCORE	_____	_____	_____

Meehan WP 3rd, Mannix R, Monuteaux MC, Stein CJ, Bachur RG. Early symptom burden predicts recovery after sport-related concussion. Neurology. 2014 Nov 7.

Second Impact Syndrome

- Second brain injury before resolution of first
- Rapid onset of potentially severe neurological symptoms
- Caused by problem with regulation of the brain's vasculature
- Increased pressure within the skull
- Can be fatal

Cuccurullo, Sara J. *Physical Medicine and Rehabilitation Board Review*. 3rd ed. New York: Demos Medical, 2015. Pages 94-97.

Potential long-term effects of concussion

Alzheimer's Dementia

Accelerated brain atrophy in patients with concussion who are at risk for dementia

Parkinson's Disease

In military personnel, mild TBI (concussion) was associated with a 56% increased risk of Parkinson's Disease



Jasmeet P. Hayes, Mark W. Logue, Naomi Sadeh, Jeffrey M. Spielberg, Mieke Verfaellie, Scott M. Hayes, Andrew Reagan, David H. Salat, Erika J. Wolf, Regina E. McGlinchey, William P. Milberg, Annjanette Stone, Steven A. Schichman, Mark W. Miller. **Mild traumatic brain injury is associated with reduced cortical thickness in those at risk for Alzheimer's disease.** *Brain*, 2017.

Raquel C. Gardner, Amy L. Byers, Deborah E. Barnes, Yixia Li, John Boscardin, Kristine Yaffe. Mild TBI and risk of Parkinson disease. *Neurology* Apr 2018

Research and development

Diagnostic

- Blood tests to determine brain injury
- Devices to determine if additional brain imaging is needed

Medications

- Medications to decrease secondary injury
- Medications to promote neural tissue recovery

Source: <https://www.ninds.nih.gov/Current-Research/Focus-Research/Focus-Traumatic-Brain-Injury>

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