

# Traumatic Brain Injury: Recovery and Complications.

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# Classification

- Primary injury:
  - Induced by mechanical force and occurs at the moment of injury;
  - contact (eg, an object striking the head or the brain striking the inside of the skull)
  - and acceleration-deceleration
- Secondary injury:
  - Not mechanically induced
  - May be delayed from the moment of impact
  - May superimpose injury on a brain already affected by a mechanical injury

These injuries are commonly found together; they are defined as follows:

- Focal injury: Includes scalp injury, skull fracture, and surface contusions; generally caused by contact
- Diffuse injury: Includes diffuse axonal injury (DAI), hypoxic-ischemic damage, meningitis, and vascular injury; usually caused by acceleration-deceleration forces

# Measures of Severity

- Glasgow Coma Scale (GCS): A 3- to 15-point scale used to assess a patient's level of consciousness and neurologic functioning
  - The total of the motor, verbal, and eye-opening scores (range, 3-15) indicates the severity of a TBI, as follows
    - 3-8 is severe TBI
    - 9-12 is moderate TBI
    - 13-15 is mild TBI
  - Duration of loss of consciousness classified as
    - mild (mental status change or loss of consciousness [LOC] < 30 min)
    - moderate (mental status change or LOC 30 min to 6 hr)
    - severe (mental status change or LOC >6 hr)
- Posttraumatic amnesia (PTA): The time elapsed from injury to the moment when patients can demonstrate continuous memory of what is happening around them

# Risk for TBI

- Males are about twice as likely as females to sustain a TBI.
- Infants and children aged 0-4 and adolescents aged 15-19 years are the 2 age groups at highest risk for a TBI.
- Adults aged 75 years or older have the highest rates of TBI-related hospitalization and death.

# How the brain functions

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# After TBI





# Recovery Process

- Some neurons may be just bruised or swollen and not permanently damaged. As the bruising and swelling improve, the neurons start to function again.
- Other parts of the brain take over the functions of the damaged areas.
- New connections between the remaining brain cells may form.



# Stages of Recovery

- Coma
- Vegetative state
- Minimally conscious state
- Recovery of full consciousness which often includes post traumatic amnesia.

# Factors Affecting Recovery

- Age at time of injury
- Area and amount of injury
- Time since injury happened
- Skills and behaviour before injury
- Motivation for recovery
- Substance use/Abuse
- Past Brain Injury/Concussion

# Aging and TBI

- Older age is a predictor for mortality following TBI independent of Glasgow Coma Scale score or injury severity.
- Mortality rates are higher for older adults compared to younger individuals
- Short and long term survivors of TBI have been found to have neurofibrillary tangles in their brains which are molecularly identical to individuals with Alzheimer's disease
- Individuals aging with a TBI have a greater lifetime risk for dementia

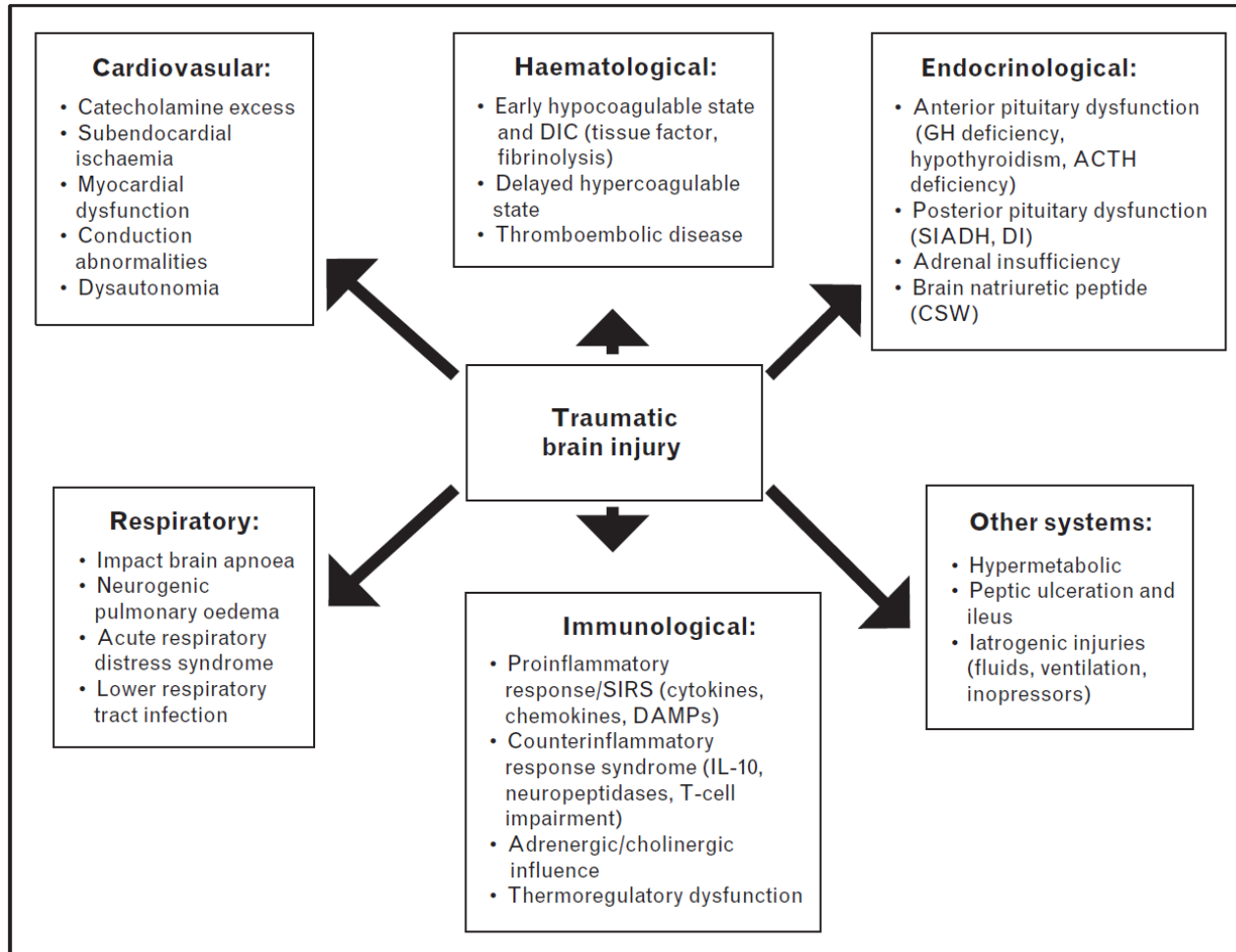
- Individuals aging with a TBI have a greater lifetime risk for dementia. The APOE4 allele is an independent predictor for poor clinical outcome, both physically and cognitively. Possession of the APOE4 allele results in higher rates of Alzheimer's disease in those with TBI.
- It is possible for older TBI patients to achieve a good functional outcome with rehabilitation.
- Recovery in rehabilitation appears to plateau after a period of time for older adults but continues to improve for younger TBI patients.

- Headache
  - Lasting more than 3 months after event or if they are debilitating require treatment
    - ? Botox
- Post-Traumatic Hydrocephalus
  - Lumbar puncture/Shunt placement
- Elevated Intra-cranial Pressure

- Heterotopic Ossification
  - Bisphosphonates/NSAIDs
  - ROM exercises
  - Surgery
- Hypertension
  - Propranolol preferred choice
- Venous Thrombo-embolic Disease

- Post-Traumatic Epilepsy/Seizures
  - Phenytoin effective during first week post-injury
  - Keppra
- Post-Traumatic Agitation
  - Anti convulsants
  - Seroquel
  - SSRIs
- Endocrine Neuropathies
- Spasticity





# Complications

- Posttraumatic seizures
  - Frequently occur after moderate or severe TBI
- Hydrocephalus
- Deep vein thrombosis
  - Incidence as high as 54%<sup>6</sup>
- Heterotopic ossification
  - Incidence of 11-76%, with a 10-20% incidence of clinically significant heterotopic ossification<sup>7</sup>
- Spasticity
- Gastrointestinal and genitourinary complications
  - Among the most common sequelae in patients with TBI
- Gait abnormalities
- Agitation
  - Common after TBI
- Chronic traumatic encephalopathy (CTE)

# Complications

Long-term physical, cognitive, and behavioral impairments are the factors that most commonly limit a patient's reintegration into the community and his/her return to employment. They include the following:

- Insomnia
- Cognitive decline
- Posttraumatic headache: Tension-type headaches are the most common form, but exacerbations of migraine-like headaches are also frequent
- Posttraumatic depression: Depression after TBI is further associated with cognitive decline, anxiety disorders, substance abuse, dysregulation of emotional expression and aggressive outbursts

Factors affecting the prognosis after brain injury:

- Previous medical history including any neurological problems
- Age
- Type and location of the injury
- Depth and duration of coma
- Presence of low blood pressure or oxygen levels after the injury
- Current findings from physical examinations, radiological studies of the brain and other tests.

# Rehab Strategies

- Patient and patient's family
- PM&R physician
- Rehabilitation nurse
- Allied health professionals: physiotherapist, occupational therapist, speech pathologist, social worker
- Neuropsychologist, clinical psychologist

- Vocational rehabilitation services and counselors
- Other medical specialties: Internist, neurosurgery, orthopedic surgery

# Case Study

- 23 yr old male with no PMH involved in MVA 8/10/2012
- Presented to UCMC with GCS 4 (Severe TBI)
- Imaging revealed diffuse hemorrhagic shear injury, hemorrhagic contusions in bilateral frontal/ant temporal, small SDH in left tentorium and left posterior occipital region without mass effect.



- Intubated on admission in Neurosurgical ICU and treated with 3% mannitol and brief pentobarbital coma
- Was on vasopressors briefly
- Developed ARDS on Hospital Day 6 treated with nitrous oxide

- Treated with Abx for pneumonia 8/21-8/30
- Developed autonomic storm requiring bromocriptine/trazodone
- PEG and percutaneous tracheostomy placed 8/22
- GCS was 11 T on discharge
- Bilateral Dopplers were negative for any DVT prior to discharge

- Admitted to HealthSouth at Drake for acute inpatient rehab 8/29/12-10/16/12
- Functional Status on admission: Max A with bed mobility/Transfers and max A for Grooming.
- Ranchos Los Amigos Scale 3 on admission
- Had R sided spastic hemiplegia with difficulty walking on discharge from HS at Drake

- Underwent R achilles tendon lengthening 10/13
- Underwent Botox injections to R Gastrocs/Post Tibialis 4/8/13 and was fitted with R AFO
- Outpatient PT/OT/ST at Healthsouth NKY 11/22/13 till 2/27/14 and 6/214 till 8/1/14
- Was able to ambulate better with L300 (Bioness) neuroprosthesis up to 100 ft with AFO after botox injections
- Was able to ambulate up to 500 ft with AFO by May 2014 with no AD

- Underwent multiple treatments of high dose Botulinum toxin to R Gastrocnemius with continued spastic plantar flexion deficits
- Due to ineffective treatment with Botox, underwent Lidocaine Tibial nerve block with good reduction in spasticity with temporary improvement in range of motion followed by phenol block using EMG under US guidance.

- Progressed with outpatient PT/OT and was fitted with new R AFO July 2014 with improvement in gait
- Drives by himself and attends college and is I with all ADLs

- HealthSouth NKY provides comprehensive treatment for patients with TBI
  - Physicians
    - PM&R/Pulmonary Critical Care/Family Physician/Nephrologist/Neurologist
  - Trained PT/OT/ST in TBI
  - Neuropsychologist
  - Rehab Nurses
  - Case Managers
  - Accreditation for TBI



# Rehabilitation Technology



**Balance System™ SD**

## Game Cycle



## Bioness Ness L300<sup>®</sup> Neural Orthosis



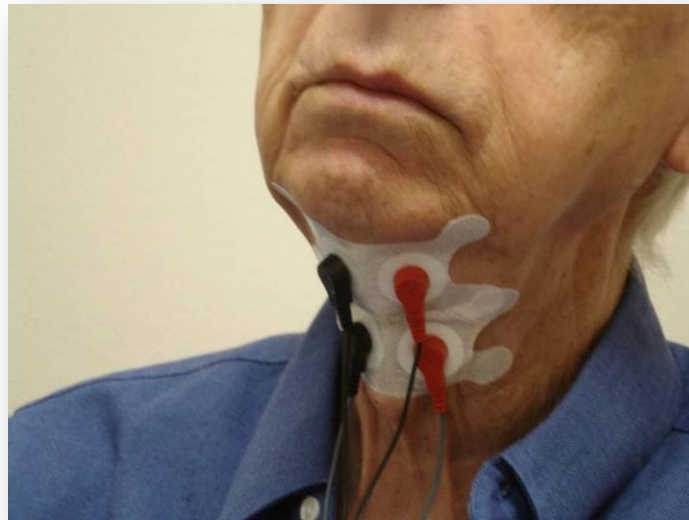
# Rehabilitation Technology

## Bioness Ness H200®



# Rehabilitation Technology

## NeuroMuscular Electrical Stimulation for Swallowing VitalStim® Therapy





# Rehabilitation Technology

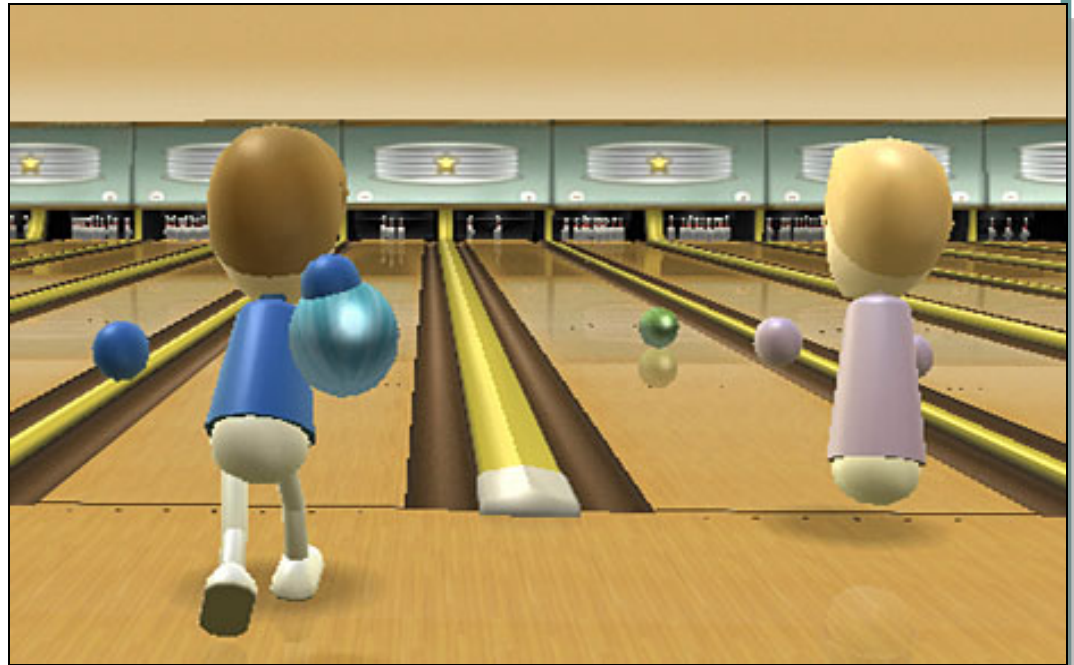
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## Robotic Assisted Therapy Motorika Reo™ Go Therapy



# Rehabilitation Technology

## Off-the-Shelf Virtual Reality



# Questions

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