Traumatic Brain Injury and Other Brain Disorders

- Billie A. Schultz, MD is a Consultant in the Department of Physical Medicine and Rehabilitation at the Mayo Clinic in Rochester, MN.
- Dr. Schultz is an Assistant Professor in the College of Medicine.
- She is board certified in PM&R and subspecialty certified in Brain Injury Medicine.
- Clinical interests include acquired brain injury and spasticity.
Traumatic Brain Injury and Other Brain Disorders

Online curriculum

Billie A Schultz, MD
Disclosures

• Financial- None

• Off Label usage of medications will be discussed in management of TBI associated complications
Objectives

• Identify common TBI related symptoms and management
• Identify various presentations and interventions of other brain related disorders including multiple sclerosis and Parkinson Disease
Traumatic Brain injury- Definition

• Injury to the brain caused by external forces
  • Does not require loss of consciousness
  • Does not require direct impact to the head
Cause of TBI
All Ages

- Falls
- Motor Vehicle-Traffic
- Violence
- Struck by/ Against
- Unknown/Other

CDC, 2014
Cause of TBI
Ages 0-4

- Falls
- Motor Vehicle-Traffic
- Violence
- Struck by/Against
- Unknown/Other

CDC, 2014
 Cause of TBI
Ages 65 and greater

Falls
Motor Vehicle-Traffic
Violence
Struck by/ Against
Unknown/Other

CDC, 2014
Cause of TBI
Ages 25-44

- Falls
- Motor Vehicle-Traffic
- Violence
- Struck by/Against
- Unknown/Other

CDC, 2014
Gender distribution of TBI based on ED visits in 2010

CDC, 2014
TBI- pathophysiology

- Primary Injury
  - Direct result of trauma
    - Contusion/lacerations
      - Common location of contusions
        - Inferior frontal lobe
        - Anterior temporal lobe
  - Diffuse axonal injury
    - Common location of DAI
      - Midline brain structures
      - Grey-white matter junctions
- Cranial nerve injury
- Diffuse vascular injury
- Focal intracranial hemorrhage
TBI-pathophysiology

• Secondary injury
  • Includes
    • Intracranial hemorrhage
    • Swelling/ Edema
    • Hypoxia
    • Infection
    • Hydrocephalus
    • Hypotension
    • Seizures
    • Vasospasm

  • Electrolyte imbalances
  • Anemia
  • Hyperthermia
  • Hyper/hypo glycemia
  • Hypercarbia
  • Hyponatremia
  • Carotid dissection
TBI- Blast injury

• Primary injury
  • Direct effects of the pressure (positive and negative) waves

• Secondary injury
  • Objects striking the person

• Tertiary injury
  • The person striking objects

• Quaternary injury
  • Associated injuries including inhalation, burns, hypoxia
TBI - Predictors of Outcome

- Definitions
  - GCS
  - PTA
Glasgow Coma Scale

- Helps to define severity - best score in 24 hours

<table>
<thead>
<tr>
<th>Score</th>
<th>Motor (6)</th>
<th>Verbal (5)</th>
<th>Eye (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>Extensor posturing to pain</td>
<td>Unintelligible</td>
<td>Opens to pain</td>
</tr>
<tr>
<td>3</td>
<td>Flexor posturing to pain</td>
<td>Inappropriate</td>
<td>Open to loud voice</td>
</tr>
<tr>
<td>4</td>
<td>Withdraws from pain</td>
<td>Confused</td>
<td>Open spontaneously</td>
</tr>
<tr>
<td>5</td>
<td>Localize to pain</td>
<td>Alert/oriented</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Obey commands</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Glasgow Coma Scale

- 3-8 - severe injury
- 9-12 - moderate injury
- 13-15 - mild injury
GCS as a predictor of outcome

- Best motor response is best predictor
- Total score predicting
- Recent evidence indicates this may not predict as well as previously thought.
Post traumatic amnesia

- Galveston Orientation and Amnesia Test (GOAT)
  - Assessed orientation, recall of circumstances, last pre-injury and first post injury memories
  - 75 or greater for 2 consecutive days is end of PTA

<table>
<thead>
<tr>
<th>Duration of PTA</th>
<th>Severity of Injury Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 minutes</td>
<td>Very mild</td>
</tr>
<tr>
<td>5-60 minutes</td>
<td>Mild</td>
</tr>
<tr>
<td>1-24 hours</td>
<td>Moderate</td>
</tr>
<tr>
<td>1-7 days</td>
<td>Severe</td>
</tr>
<tr>
<td>1-4 weeks</td>
<td>Very severe</td>
</tr>
<tr>
<td>&gt; 4 weeks</td>
<td>Extremely severe</td>
</tr>
</tbody>
</table>
TBI- Other predictors

• Imaging
• Age
• Pupillary reaction
• SSEPs
• Doll’s eye sign
• Caloric testing
• Motor response to pain
• Time
TBI- outcome scales

- Glasgow Outcome Scale
  - 1-5 (1=death; 5=good recovery)

- Disability Rating Scale
  - 30 point scale (measures eye opening, verbalization/communication, motor responsiveness, feeding, toileting, grooming, overall level of functioning, employability)

- Functional Independence Measure (FIM)
  - 18-126 (cognitive and motor domains)
# TBI - Disorders of Consciousness

<table>
<thead>
<tr>
<th></th>
<th>Sleep/wake cycles</th>
<th>Eye opening</th>
<th>Visual tracking</th>
<th>Evidence of environmental awareness</th>
<th>Consistent command following</th>
<th>Functional object use/ use of a communication system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coma</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Vegetative state</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Minimal conscious state</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Emergence</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
### TBI- Rancho Los Amigos

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No response</td>
</tr>
<tr>
<td>II</td>
<td>Generalized response</td>
</tr>
<tr>
<td>III</td>
<td>Localized response</td>
</tr>
<tr>
<td>IV</td>
<td>Agitated</td>
</tr>
<tr>
<td>V</td>
<td>Confused and inappropriate</td>
</tr>
<tr>
<td>VI</td>
<td>Confused and appropriate</td>
</tr>
<tr>
<td>VII</td>
<td>Automatic and appropriate</td>
</tr>
<tr>
<td>VIII</td>
<td>Purposeful and appropriate</td>
</tr>
</tbody>
</table>
Neuropsychological testing

• Assess cognitive and emotional issues which may affect function.
Functional limitations secondary to TBI

- Motor
  - Impaired mobility
  - Impaired ADLs

- Behavior
  - Agitation
  - Disinhibition
  - Emotional lability
  - Abulia

- Social/cognitive
  - Return to work, school
  - Need for cognitive supervision
  - Return to driving
Management of TBI associated complications
TBI- arousal

• Sleep wake regulation
• Fatigue
• Medication options
  • Stimulants
  • Dopaminergic agents

Giancino, 2012
Post traumatic agitation

- Excessive psychomotor activity
- Evaluate for underlying etiology
- Education
- Treatment
  - Nonpharmacologic
  - Pharmacologic
- Monitor results of intervention
Treatment of post-traumatic agitation

Non-pharmacologic
- Environmental modification
- Education of staff/family
- Behavior modifications

Pharmacologic
- Beta-blockers
- Anti-convulsants
- Anti-psychotics
- Neuro-stimulants
- Dopaminergic agents
- Benzodiazepines
- Lithium
Post Traumatic Hydrocephalus

• True hydrocephalus vs. ex vacuo changes

• Symptoms
  • Cognitive changes
  • Gait dysfunction
  • Urinary incontinence

• Evaluation
  • Imaging- CT head

• Treatment
  • Lumbar puncture
  • Shunting
Heterotopic Ossification

• Formation of mature bone in soft tissue
• Risks- neurologic injury, trauma, surgery, burns
• Symptoms- pain, warmth, limited joint ROM
• Evaluation- Triple phase bone scan
• Treatment- physical therapy, NSAIDs, bisphosphonates, radiation, surgery
Thromboembolic Disease

• Risks- Virchow triad

• Symptoms-
  • DVT- none, fever, edema, warmth, pain
  • PE- none, chest pain, tachypnea/-cardia, hypoxia

• Evaluation-
  • DVT- venous US
  • PE- CT angio, VQ scan

• Treatment-
  • Anticoagulation, mechanical thrombectomy or thrombolysis in select cases.
Post-traumatic Epilepsy/seizures

• Immediate vs. early vs. late seizures
• Risk factors
• Prophylaxis
• Treatment
Urinary dysfunction

• Covered in detail elsewhere

• Specific to brain injury
  • Cortical lesions
  • Loss of inhibition
Endocrine complications

- SIADH
- Cerebral salt wasting
- Diabetes Insipidus
<table>
<thead>
<tr>
<th></th>
<th>SIADH</th>
<th>DI</th>
<th>CSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid status</td>
<td>Iso</td>
<td>Iso (if able to match fluids in/out)</td>
<td>Dry</td>
</tr>
<tr>
<td>Sodium (serum)</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Osmolality (serum)</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Osmolality (urine)</td>
<td>High</td>
<td>Low</td>
<td>Normal</td>
</tr>
<tr>
<td>Treatment</td>
<td>Fluid restriction</td>
<td>Desmopressin</td>
<td>Fluid supplementation</td>
</tr>
</tbody>
</table>
Spasticity

• Upper motor neuron mediated velocity-dependent increase in muscle tone
• Examination- quantify spasticity
• Treatment should be goal oriented
• Treatment
  • Stretching, splints and braces
  • Oral medications
  • Chemo-denervation
  • Intrathecal therapy
  • Surgery
Cognitive Rehabilitation

• Focuses on difficulties with attention, learning or memory, executive functioning

• Remediation

• Compensation

Cicerone, 2011
Mild TBI and concussion

• Definition
  • GCS 13-15
  • +/- LOC (if present not to exceed 30 minutes)
  • PTA not exceeding 24 hours
  • Complicated if intracranial imaging findings on CT day of injury

• Diagnosis
  • Clinical based on symptoms and exam
    • Sideline testing
    • IMPACT and similar neuropsychologic profiles
<table>
<thead>
<tr>
<th>Stage</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-no activity (symptomatic)</td>
<td>Cognitive/physical rest</td>
</tr>
<tr>
<td>1- light aerobic</td>
<td>Intensity less than 70%; no resistance training</td>
</tr>
<tr>
<td>2- sport-specific exercise</td>
<td>Drills, no head impact activities</td>
</tr>
<tr>
<td>3- noncontact training drills</td>
<td>More complex training drills, progressive resistance training</td>
</tr>
<tr>
<td>4- Full-contact practice</td>
<td>Participate in normal training</td>
</tr>
<tr>
<td>5- Return to play</td>
<td>Normal game play</td>
</tr>
</tbody>
</table>

McCrory, 2013
Post-concussive syndrome

• Multi-disciplinary approach
  • Education
  • Symptom management
    • Cognitive rehabilitation
    • Psychology/psychiatry
    • Headache/pain management
    • Sleep assessment/management
    • Vestibular rehabilitation
    • Vocational rehabilitation
    • Educational assistance
Chronic Traumatic Encephalopathy

- Tauopathy of uncertain incidence, etiology and clinical significance
Parkinson Disease

• Cause- loss of substantia nigra pars compacta (produces dopamine) and presence of Lewy bodies

• Symptoms
  • Rest tremor*
  • Bradykinesia*
  • Rigidity*
  • Hypophonia
  • Micrographia

• Parkinson Plus
<table>
<thead>
<tr>
<th>Parkinson Plus</th>
<th>Lewy Body Dementia</th>
<th>Progressive Supranuclear Palsy</th>
<th>Multiple System Atrophy</th>
<th>Corticobasal Degeneration</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Motor symptoms of PD</td>
<td>• Motor symptoms of PD</td>
<td>• Bradykinesia</td>
<td>• Bradykinesia</td>
<td>• Bradykinesia</td>
</tr>
<tr>
<td>• Dementia (progressive)</td>
<td>• Decreased vertical gaze</td>
<td>• Rigidity</td>
<td>• Rigidity</td>
<td>• Rigidity</td>
</tr>
<tr>
<td>• Visual hallucinations</td>
<td></td>
<td>• Ataxia</td>
<td>• Ataxia</td>
<td>• Apraxia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Autonomic dysfunction</td>
<td></td>
<td>• Alien limb syndrome</td>
</tr>
</tbody>
</table>
Parkinson Disease

• A clinical diagnosis

• Other associated symptoms/complications
  • Dysphagia
  • Pain
  • Sexual dysfunction
  • Depression
  • Pulmonary dysfunction
  • Orthostasis
Medical treatment of Parkinson Disease

• Medications
  • Anticholinergic
  • Antiviral
  • Dopamine replacement
  • Dopamine agonist
  • Selective dopamine agonist
  • MAO B inhibitors
  • COMT inhibitors

• Surgical
  • Deep brain stimulator
Rehabilitation treatment of Parkinson Disease

• Goals- improve muscle strength, mobility and function
• Gait training
• Assessment of ADLs with adaptive techniques/equipment
• Speech pathology
• Dysphagia assessment
Multiple Sclerosis

- Inflammatory demyelinating disorder

- 4 types
  - Relapsing-remitting
  - Secondary progressive
  - Primary progressive
  - Progressive relapsing

- Diagnosis
  - Imaging
  - Clinical symptoms
  - Positive CSF
Multiple Sclerosis - symptoms

- Vision
- Sensory symptoms
- Motor symptoms
- Neurogenic bowel
- Neurogenic bladder
- Fatigue
- Sexual dysfunction
- Cranial nerve involvement
- Cerebellar symptoms
- Cognitive changes
- Mood disorders
Multiple Sclerosis - Medical Treatment

• Treat the disease
  • Immunomodulatory drugs
  • Antiproliferative drugs
  • Block extracellular processes

• Treat the symptoms
  • Spasticity
  • Fatigue
  • Pain
  • Neurogenic bladder/bowel
  • Mobility
Multiple Sclerosis- rehabilitation treatment

• Dependent on symptoms

• Goals- decrease spasticity, improve mobility, improve function
  • Physical therapy
  • Occupational therapy
  • Speech and language pathology
Suggested Reading material

- Textbooks
  - General PMR
  - Braddom’s
  - DeLisa’s
  - Frontera’s
- Brain Injury
  - Zalser’s
References


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