The Effects of Traumatic Brain Injury (TBI) on Sleep

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Sleep needs vary from one person to another.
Sleep is affected by multiple environmental factors.
Sleep is affected by both mental and physical issues.
Sleep is affected by many medications.
Sleep is affected by lesions in several brain regions.
Leading cause of death in North America for individuals between ages 1-45

Major economic burden from resulting medical costs and lost productivity (study from 2000 reported losses of $9.2 billion and $51.2 billion, respectively)

Overall incidence in the US is 538/100,000 or 1.5 million new cases reported in 2003
Risk Factors for TBI

- Men compared to women
- Lower socioeconomic status
- Underlying psychiatric illness
- Underlying cognitive disorders
Leading Causes of TBI

- Falls (28%) – leading cause in older age groups
- MVA (20%) – leading cause in younger age groups
- Violence – Assault or Abuse
Traumatic Brain Injury in Military Combat
NFL Concussion Syndrome
Symptoms in Mild TBI

- Headache
- Memory / Cognitive Changes
- Dizziness
- Blurred Vision
- Mood Changes
- Sleep Disturbances
Symptoms of Moderate-Severe TBI

- Intractable Headaches
- Nausea/vomiting
- Seizures / Epilepsy
- Lethargy
- Slurred Speech
- Confusion
- Weakness/Numbness
- Agitation
- Ataxia / Imbalance
Sleep Disturbances In TBI

- Occur in 30-70% of all TBI cases
- Occur more frequently in Mild TBI than in Severe TBI
- Causes secondary disability from slowed rehabilitation and return to work
Sleep Disturbances in TBI

- **Acute Phase**
  - First 10 days after injury
  - 30% patients will have Sleep complaints

- **Subacute Phase**
  - 6 weeks post injury
  - 50% patients will have sleep complaints

- **Chronic Phase**
  - >6 months post injury
  - 27-50% patients with Sleep complaints
Sleep Disturbances in TBI

- Excessive Daytime Sleepiness
- Insomnia
- Specific Sleep Disorders – OSA, RLS
- Circadian Rhythm Disturbance
- Parasomnias
How Does TBI Lead to Sleep Disturbance?
Part of the reticular activating system (RAS)

Network of neurons running through the upper brainstem, thalamic region, hemispheres
Ascending Arousal System
Circadian Rhythm and the Suprachiasmatic Nucleus (SCN)
Circadian Rhythm

- Light --- Activation of SCN --- Inhibition of Pineal Gland --- Decreased Melatonin --- Wakefulness

- Dark --- Inhibition of SCN --- Pineal Activation --- Increased Melatonin ---- Sleep
Hypocretin - 1

- Aka: Orexin
- Neuropeptide that regulates arousal / wakefulness / appetite
- Deficiency of Hypocretin-1 seen with narcolepsy
- Low CSF hypocretin-1 can be seen initially after TBI
- Levels tend to normalize by 6 months post injury
Pathophysiology of TBI

- **Primary brain injury**
  - Structural damage at the time of impact
  - From contact, acceleration-deceleration, rotational forces

- **Secondary brain injury**
  - Damage from subsequent cellular processes from the primary injury
  - Hypoxia, increased ICP
Pathophysiology of TBI

- **Focal Injury**
  - Contusion
  - Subdural / Epidural
  - Intraparenchymal Hemorrhage

- **Diffuse Injury**
  - Often caused by acceleration/deceleration forces
  - Shearing forces
  - Widespread axonal injury
Coup – Contrecoup Injury
Axonal Shearing / DAI

Diffuse axonal injury
MRI Changes in TBI
How Does TBI Cause Sleep Disturbance?

- Hypothalamic Injury
  - Decreased CSF Hypocretin 1
  - Decreased CSF Histamine Levels

- Injury to SCN or Thalamus
  - Direct trauma
  - Prolonged hospitalization / Loss of environmental clues

- Melatonin

- Depression / Pain / Psychological Factors
Excessive Daytime Somnolence / Hypersomnia

- Injury to the brainstem
  - Rostral pons / Caudal midbrain / Thalamus
- Microhemorrhages in affected areas
- Shearing injury
Trouble initiating and maintaining sleep
Common effect of TBI
Can occur with or without subjective daytime sleepiness
50% of TBI patients reported insomnia symptoms
Can be seen in increased frequency with comorbid PTSD
Insomnia

- Associated with injury to the anterior temporal and inferior frontal regions
- This region is associated with sleep initiation therefore damage leads to insomnia
Mixed Hypersomnia / Insomnia

- Reported with lesions of the nucleus suprachiasmaticus
- Causes disturbance in the circadian rhythm
CoMorbidity in TBI Which May Affect Sleep

- Depression and Anxiety
- Post-Traumatic Stress Disorder
- Chronic Pain