Sleep disorders in pediatric TBI

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Disclosures

• None
Objectives

- Discuss the incidence of sleep problems after pediatric TBI.
- Understand how sleep dysfunction may contribute to other behavioral and cognitive problems.
- Review potential interventions available for sleep dysfunction.
Sleep disturbances
Sleep disturbances in adults with TBI

- **Acute**
  - Central apnea (36%)
  - Disorders of initiating and maintaining sleep (57%)
- **Chronic**
  - Disorders of excessive somnolence (38-46%)
  - OSA (23%), PLMS (7%), narcolepsy (6%)

Cohen et al, *J Neurol Neurosurg Psychiatry* 1992
Sleep and acute mTBI

- Children ages 11-17 years
- Blunt head trauma, GCS 14-15
- Required hospitalization
- Symptom checklist
  - Admission and 2-3 wk f/u

- n = 116
- n = 62 at follow up

Blinman et al, J Ped Surg 2009
<table>
<thead>
<tr>
<th>Symptom</th>
<th>Initial visit (%)</th>
<th>Follow-up visit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>71.6</td>
<td>31.8</td>
</tr>
<tr>
<td>Nausea</td>
<td>35.3</td>
<td>15.9</td>
</tr>
<tr>
<td>Vomiting</td>
<td>17.2</td>
<td>6.3</td>
</tr>
<tr>
<td>Balance problems</td>
<td>60.3</td>
<td>25.4</td>
</tr>
<tr>
<td>Dizziness</td>
<td>60.3</td>
<td>27.0</td>
</tr>
<tr>
<td>Fatigue</td>
<td>67.2</td>
<td>30.2</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>55.2</td>
<td>38.1</td>
</tr>
<tr>
<td>Sleeping more than usual</td>
<td>38.8</td>
<td>33.3</td>
</tr>
<tr>
<td>Sleeping less than usual</td>
<td>54.3</td>
<td>22.2</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>59.5</td>
<td>27.0</td>
</tr>
<tr>
<td>Light sensitive</td>
<td>39.7</td>
<td>14.3</td>
</tr>
<tr>
<td>Noise sensitive</td>
<td>31.0</td>
<td>11.1</td>
</tr>
<tr>
<td>Irritable</td>
<td>39.7</td>
<td>30.2</td>
</tr>
<tr>
<td>Sadness</td>
<td>33.6</td>
<td>19.1</td>
</tr>
<tr>
<td>Nervousness</td>
<td>44.0</td>
<td>22.2</td>
</tr>
<tr>
<td>Feeling more emotional</td>
<td>41.4</td>
<td>25.4</td>
</tr>
<tr>
<td>Numbness or tingling</td>
<td>37.9</td>
<td>19.1</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>67.2</td>
<td>36.5</td>
</tr>
<tr>
<td>Feeling mentally foggy</td>
<td>41.4</td>
<td>19.1</td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>46.6</td>
<td>34.9</td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>67.2</td>
<td>34.9</td>
</tr>
<tr>
<td>Visual problems</td>
<td>30.2</td>
<td>7.9</td>
</tr>
</tbody>
</table>
Sleep and acute mTBI
Sleep and chronic TBI

- Children infant to 18 years
- TBI (all severity)
- Caregiver report of difficulties
  - Neurological
  - Neurocognitive
  - Behavioral
  - School
- Interview at 1, 4, 10 months post injury

Hooper et al, *NeuroRehabilitation* 2004
Sleep and chronic TBI

- \( n = 681 \)
  - 409 from ED
  - 272 from inpatient
- 83\% mild
- 5\% moderate
- 12\% severe

Hooper et al, *NeuroRehabilitation* 2004
## Sleep and chronic TBI

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>One-month follow-up</th>
<th>Four month follow-up</th>
<th>Ten month follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ED</td>
<td>IH</td>
<td>TOTAL</td>
</tr>
<tr>
<td>Fatigue</td>
<td>7.8</td>
<td>17.9</td>
<td>11.3</td>
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<tr>
<td>Sleep probs.</td>
<td>12.4</td>
<td>19.1</td>
<td>14.7</td>
</tr>
</tbody>
</table>
Longitudinal evaluation of sleep in TBI

- Children ages 6-12 years
- Compared moderate TBI, severe TBI and orthopedic injuries
- Report of pre-injury sleep disturbance
- Prospective assessment of post-injury sleep
  - 6, 12, 48 mo

Longitudinal evaluation of sleep in TBI

- 56 moderate TBI
- 53 severe TBI
- 80 OI

Results:
- Daytime somnolence
- Increased nocturnal sleep
- Disturbances lasted years later

Longitudinal evaluation of sleep in TBI

(a) Severe TBI and Moderate TBI

(b) Severe TBI and Orthopedic injury

Sleep concerns (raw)

Time since injury (years)
Effects of sleep dysfunction
Effects of sleep deprivation

- Executive function is affected early
- Performance speed decreases, followed by accuracy
- Inability to concentrate, shift tasks, understand novel ideas
- PET scans show decreased metabolism in prefrontal and parietal areas
- Depressed mood, impulsivity, oppositional behavior

Outcomes on inpatient rehabilitation

- Prospective cohort of adults
- Moderate or severe TBI
- Sleep log x 1 week
- $n = 31$
- 68% had sleep disturbance

Makely et al, *Neurorehabil Neural Repair* 2008
Outcomes on inpatient rehabilitation
Outcomes on inpatient rehabilitation
Outcomes on inpatient rehabilitation

Sleep-Wake Cycle Disturbance

Length of Stay in Rehabilitation (Weeks days)

Absent

Present

Seattle Children's®

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Outcomes on inpatient rehabilitation

Conclusions:
• Sleep disturbance → longer LOS
• More impaired on admission to rehab
• Decreased FIM efficiency

Makely et al, Neurorehabil Neural Repair 2008
Executive function

- Adolescents age 12-18
- TBI <6 months (all severity)
- Hospitalized

Assessments:
- Epworth Sleepiness Scale
- Parent-report Sleepiness Scale
- BRIEF (self and parent)

Osorio et al, *PMR* 2013
Executive function

- $n = 102$ adolescents
  - 42 mTBI
  - 60 moderate/severe TBI
- Mean age 15 years
- Mean 15 weeks post injury

Osorio et al, *PMR* 2013
Executive function

Results:

• Excessive somnolence in moderate-severe TBI
• Worse executive function (all TBI)
• Excessive daytime somnolence is significantly associated with executive dysfunction

Osorio et al, *PMR* 2013
Treatment
Melatonin vs Amitriptyline

- RCT, double-blind, cross-over
- Ages 16-65 years
- TBI >6 months (all severity)
- Sleep disturbance (initiation or maintenance)
- Compare melatonin and amitriptyline
- n = 7

Kemp et al, *Brain Injury* 2004
Melatonin vs Amitriptyline

- Sleep diary
- Brief neuropsych
- Melatonin 5mg or amitriptyline 25mg x 1 month
- Repeat interview and neuropsych
- 2 week washout

Kemp et al, *Brain Injury* 2004
Melatonin vs Amitriptyline

Results:
- No difference in sleep variables between the 2 drugs
- Trend toward improvement with both drugs
- Small to medium effect sizes
  - Sleep latency – amitriptyline 0.47
  - Sleep duration – amitriptyline 0.56
  - Daytime alertness – melatonin 0.42
- No adverse effects on cognition

Kemp et al, *Brain Injury* 2004
Sleep medication and effects on cognition

• Trazodone improves sleep duration
  • Possible effects on cognition
• Benzodiazepines impair neuronal recovery
• Zolpidem impairs consolidation of new learning

Larson et al, *J Head Trauma Rehabil* 2010
Summary

- Sleep initiation is problematic, especially in acute
- Excessive daytime somnolence is common
- Sleep dysfunction can persist
- Further study is needed to characterize types of disorders
- Sleep dysfunction impacts length of stay and function
- Excessive daytime somnolence contributes to executive dysfunction
- Melatonin, amitriptyline and trazodone can be helpful
- Benzodiazepines and zolpidem may impair cognitive recovery
References