Insomnia in workers with delayed recovery from mild traumatic brain injury

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  - Consulting fees: none
  - Other: none
Presentation outline

• Introduction, defining insomnia

• Original research "Insomnia in workers with delayed recovery from mild TBI"

• Original research "Insomnia and disability in workers with delayed recovery from mild TBI"

• Implications for brain injury medicine, occupational health and safety, rehabilitation, insurer, and aging worker
Introduction

- Traumatic brain injury (TBI), “an alteration in brain function, or other evidence of brain pathology, caused by an external force”¹ can produce a number of effects culminating in sleep dysfunction

- Clinicians dealing with TBI are left with the decision of whether or not additional investigation and treatment of poor sleep is worthwhile

- Research to date has not produced uniform results on which a decision can be based

- My talk today covers topics of insomnia and disability in persons with delayed recovery from mild TBI

Insomnia in workers with delayed recovery from mild traumatic brain injury

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Objectives

- Develop a construct of insomnia in TBI
- Describe study population: workers with delayed recovery from mTBI
- Investigate associations between insomnia and other relevant clinical and non-clinical variables
Insomnia¹

- Complaint of inadequate sleep despite adequate opportunity
- Classified according to nature of sleep disruption and duration:
  - Difficulty falling asleep
  - Difficulty maintaining sleep
  - Waking up too early
  - Feeling unrefreshed upon awakening

Fig. 1. Construct of insomnia in traumatic brain injury. Unidirectional arrows from constructs (i.e., circles) to items (i.e., rectangles) represent reflective models, and from items to constructs, formative models. Bidirectional arrows represent a combination of reflective and formative elements. Based on Fayer and Hand QOL Model, 1997.
Methods

- Cross-sectional study
- Recruitment: May 2012-May 2014
- TRI-UHN Neurology Services, WSIB Clinic
- Data: self-report standardized questionnaires, medical, and insurer’s files
Study participants

Neurology Services, of Toronto Rehab, assess approximately 300 workers each year

May 2012

Workers with suspected traumatic brain injury (TBI) consented to participate in research study

Excluded: individuals without a brain injury diagnosis (n=8) and individuals with brain injury due to electrocution (n=2)

May 2014

Workers with a TBI diagnosis (n=100)

Excluded: individuals diagnosed with moderate-severe TBI (n=6)

Workers with a mild TBI/concussion diagnosis (n=94)
Results

- N=94
- Median time since injury= 197 days (Q1-Q3: 139-416)
- Mean age (SD)=45.2±9.9
- N males (%)= 58 (62)
- N married/common law (%)= 69 (73)
- N w/ dependent children in household (%)= 55 (61)
- Education, N(%):
  - ≤high school=34 (36)
  - High school/college or prof degree= 32 (34)
  - ≥university= 24 (27)
- N native language English (%)= 77 (82)
- Mean pre-disability weekly income (SD)= $1056 (510)
Pre-morbid diagnoses, DSM-IV TR

*N=90, all else N=94
# Results

<table>
<thead>
<tr>
<th>#MVCs in past 5 years</th>
<th>1</th>
<th>21.3%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>8.5%</td>
</tr>
<tr>
<td></td>
<td>≥3</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shift-work</th>
<th>47.9%</th>
<th>Rotating</th>
<th>84.4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night</td>
<td></td>
<td>15.6%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#work-related injuries in past 5 years</th>
<th>1</th>
<th>63.8%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td>≥3</td>
<td>10.6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accident involvement due to sleepiness</th>
<th>Yes</th>
<th>8.5%</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Pre-/post-morbid sleep disorders</th>
<th>SA</th>
<th>10.6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated?</td>
<td>Yes</td>
<td>80%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gain weight since injury</th>
<th>Yes</th>
<th>68.5%</th>
</tr>
</thead>
</table>
# Results

<table>
<thead>
<tr>
<th>Work status (n=94)</th>
<th>Disability</th>
<th>57%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Part-time/full-time</td>
<td>43%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GAF score (n=88)</th>
<th>51-60</th>
<th>32%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>61-70</td>
<td>63%</td>
</tr>
<tr>
<td></td>
<td>71-80</td>
<td>5.7%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tension with (n=87)</th>
<th>Employer</th>
<th>36%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WSIB</td>
<td>15%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Previous WSIB claims (n=88)</th>
<th>Yes</th>
<th>9%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family difficulties (n=88)</td>
<td>Yes</td>
<td>62%</td>
</tr>
</tbody>
</table>
Symptoms at assessment

- Head/neck pain
- Cognition-related
- Mood-related
- Sleep-related
- Balance
- Bodily pain
- Photo/phonophobia
- Fatigue

%n
Results: comorbid disorders

- Depression: 60%
- Arthritis: 40%
- Sleep apnea: 10%
- Heart disease: 10%
- Diabetes: 5%
- Seizure disorder: 5%
- COPD: 5%
- Fibromyalgia: 5%

#medical conditions = 2.2 ± 1.0
Use of medications/substances

- Tricyclic...
- Antihistamines
- Narcotic analgesics
- Blood pressure meds
- SSRIs
- Benzodiazepines
- Alcohol (daily)
- Recreational drugs
- Non-benzodiazepines

%
Sleep-related variables

- Bedtime instability ≥61min
- Time to fall asleep ≥30min
- Losing ≥30min of night’s sleep
- Taking nap in the day
Results

- 69% of workers displayed insomnia; significantly higher than reported in a previous meta-analytical review (50%)
- Strong association between depression and insomnia (30% of variance in final model); relationship reported previously
- Frequency and severity of insomnia independent of sex
- Increasing age associated with insomnia
Results cont’d

- Previous head trauma strongly associated with lower insomnia severity

- Use of tricyclic antidepressants associated with greater insomnia severity

- Bed time and wake time instability associated with insomnia

- Longer period between usual and latest bed or wake times reflected more severe insomnia
Flow chart: stepwise multiple regression analysis procedure

Model 1: Socio-demographic (n=90)
- Children in household
- English as first language
- Mantal status
- Weekly income

Model 2: Injury-related (n=84)
- Mechanism of injury
- Non-specific MRI findings
- Previous head injury
- Time since injury

Model 3: Medical (n=93)
- Depression and/or anxiety diagnosis
- Diabetes mellitus diagnosis
- Heart disease diagnosis
- Medical comorbidities

Model 4: Psychiatric (n=88)
- Anxiety (HADS-A)
- Axis IV-TR cluster B
- Axis IV-TR cluster C
- Axis IV-TR cognition disorder
- Axis IV-TR mood disorder
- Depression (PHQ-9)

Model 5: Primary sleep disorders (n=9)
- Observed breathing pause at night
- Restless legs
- Sleep disorder diagnosis
- Snoring

Model 6: Claim-, social-, and family-related (n=87)
- Axis IV-TR possible/probable malingerer
- Family difficulties
- Having a close friend
- Working status

Model 7: Medications use effects (n=88)
- Alcohol
- Recreational substance use
- Selective serotonin reuptake inhibitors (SSRIs)
- Tricyclic antidepressants (TCAs)

Model 8: Behavioral and environmental (n=92)
- Bedtime stability
- Caffeinated drinks
- Napping
- Post-injury weight gain
- Wake time stability

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Input*

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Significant (p≤0.1)

Age**

Previous head injury***

Depression and/or anxiety diagnosis

Pain**

Axis IV-TR cluster C

Depression (PHQ-9)**

Restless legs

Age

SSRIs

TCA

Wake time stability

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Final model (n=88):

Age

Depression (PHQ-9)

Previous head trauma

TCAs

Wake time stability
**Insomnia severity index (ISI)** (Cronbach’s α=0.86) item-total score correlations. Width of spheres corresponds to strength of correlation.
Conclusions

- Study suggests insomnia highly prevalent in persons with delayed recovery from mTBI/concussion

- Factors associated with insomnia in this population are clinical and non-clinical, majority modifiable—emphasized the need to inclusion of sleep investigation in the agenda of health care providers

- Adequate intervention for insomnia could reduce/prevent the development of depression, expedite recovery, enhance rehabilitation outcomes
Objectives:

- Investigate self-perceived disability in a sample of workers with delayed recovery from mTBI
- Investigate how sleep dysfunction, characterized as insomnia, associated with disability in workers with delayed recovery from mTBI?
Hypotheses

Figure: Hypothesized relationships related to mTBI disability outcome. Red colour indicates the primary hypothesis, previously unexplored. Black colour indicates other tested relationships, previously described in the literature.
Diagnostic modeling study

- **Primary explanatory variable:** insomnia
  - Assessment: insomnia severity index
  - Continuous variable, scored 0-28

- **Outcome variable:** perceived multi-domain functional impairment
  - Assessment: Sheehan disability scale (SDS)
  - 3 domains: work, social, home/family
  - Each subscale scored 0-10, total /30
  - Categorized:
    - Mild/moderate global disability (<21) (n=36)
    - Marked/extreme global disability (21-30) (n=58)
Methods: covariates tested

- **Socio-demographic:**
  - Age (continuous, years)
  - Sex (M/F)

- **Occupational/psychosocial status:**
  - Tension with WSIB (yes/no)
  - Tension with employer (yes/no)
  - Time since injury (days)
Methods: covariates tested cont’d

- **Clinical:**
  - **Insomnia** (continuous, scored 0-28, sum of insomnia indicators over past months)
  - **Pain** (continuous, scored 0-30, sum of pain indicators over past 24 hours)
  - **Depression** (continuous, scored 0-30, sum of depression indicators over past 2 weeks)
  - **Anxiety** (continuous, scored 0-28, sum of anxiety indicators over past 2 weeks)
Statistical analyses

- **Descriptive:**
  - Univariate and bivariate statistics by outcome level
  - Continuous – t-tests if continuous
  - Categorical – chi-squared

- **Analytic:**
  - Approach: multivariable binomial logistic regression
  - Full model approach → strongly associated variables from literature (i.e., systematic reviews, multiple studies with consistent associations) included
<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall, mean (SD) or n (%)</th>
<th>Marked/extreme disability</th>
<th>Mild/moderate disability</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Age (yrs)</td>
<td>45.2 (9.9)</td>
<td>45.5 (9.8)</td>
<td>44.5 (10.5)</td>
<td>0.67</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>58 (61.7)</td>
<td>43 (74.1)</td>
<td>15 (25.9)</td>
<td>0.93</td>
</tr>
<tr>
<td>Female</td>
<td>36 (38.3)</td>
<td>27 (75.0)</td>
<td>9 (25.0)</td>
<td></td>
</tr>
<tr>
<td><strong>Occupational/injury-related</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time since injury (days)</td>
<td>509 (1097)</td>
<td>524.5 (1200)</td>
<td>465.3 (740.5)</td>
<td>0.78</td>
</tr>
<tr>
<td>Employer/WSIB tension</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>38 (40.4)</td>
<td>29 (76.3)</td>
<td>9 (23.7)</td>
<td>0.89</td>
</tr>
<tr>
<td>No</td>
<td>49 (52.1)</td>
<td>38 (77.6)</td>
<td>11 (22.4)</td>
<td></td>
</tr>
<tr>
<td>Not reported</td>
<td>7 (7.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently working, FT or PT</td>
<td>40 (42.6)</td>
<td>27 (67.5)</td>
<td>13 (32.5)</td>
<td>0.18</td>
</tr>
<tr>
<td>On disability or laid off</td>
<td>54 (57.4)</td>
<td>43 (79.6)</td>
<td>11 (20.4)</td>
<td></td>
</tr>
<tr>
<td><strong>Clinical</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insomnia Severity Score (0-28)</td>
<td>17.5 (6.1)</td>
<td>19.1 (4.8)</td>
<td>12.7 (6.9)</td>
<td>0.0002*</td>
</tr>
<tr>
<td>Depression Scale Score (0-30)</td>
<td>16.8 (6.7)</td>
<td>18.3 (5.7)</td>
<td>12.3 (7.3)</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>Pain Rating Scale Score (0-30)</td>
<td>15.9 (6.4)</td>
<td>16.9 (5.8)</td>
<td>12.9 (7.1)</td>
<td>0.0073*</td>
</tr>
<tr>
<td>Variable</td>
<td>Unadjusted OR (95% CI)</td>
<td>Adjusted OR (95% CI)</td>
<td>Wald $\chi^2$ statistic</td>
<td>p-value</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>------------------------</td>
<td>----------------------</td>
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</tr>
<tr>
<td><strong>Insomnia Severity Score</strong></td>
<td>1.21 (1.10, 1.34)</td>
<td>1.16 (1.03, 1.31)</td>
<td>5.89</td>
<td>0.015</td>
</tr>
<tr>
<td><strong>Age (per 5 year increase)</strong></td>
<td>1.05 (0.83, 1.33)</td>
<td>0.96 (0.71, 1.28)</td>
<td>0.090</td>
<td>0.761</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male (ref)</td>
<td>1.00</td>
<td>1.00</td>
<td>0.007</td>
<td>0.930</td>
</tr>
<tr>
<td>Female</td>
<td>1.05 (0.40, 2.72)</td>
<td>1.05 (0.31, 3.53)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Time since injury (per 90 days)</strong></td>
<td>1.01 (0.96, 1.05)</td>
<td>0.99 (0.95, 1.03)</td>
<td>0.211</td>
<td>0.653</td>
</tr>
<tr>
<td><strong>Employer/WSIB tension</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (ref)</td>
<td>1.00</td>
<td>1.00</td>
<td>0.290</td>
<td>0.592</td>
</tr>
<tr>
<td>Yes</td>
<td>0.93 (0.34, 2.55)</td>
<td>0.73 (0.23, 2.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Depression Scale</strong></td>
<td>1.17 (1.08, 1.28)</td>
<td>1.06 (0.94, 1.19)</td>
<td>0.913</td>
<td>0.340</td>
</tr>
<tr>
<td><strong>Pain Rating Scale</strong></td>
<td>1.11 (1.03, 1.20)</td>
<td>1.04 (0.94, 1.16)</td>
<td>0.553</td>
<td>0.462</td>
</tr>
</tbody>
</table>
The odds of perceiving higher global disability were greater in those with more severe clinical insomnia.

Previous confounders (psychosocial status, depression) were not significant after full adjustment.

Results highlight clinical focus on addressing insomnia in mTBI.
Limitations

- Cross-sectional design – cannot provide causal evidence
- Sample representativeness
- Longitudinal interplay between factors in predicting poor sleep after workers injuries remains to be determined
- Self-report measures utilized in the study, despite previous use in the TBI population, have not been validated in this group
Insomnia in the TBI population: implications
Implications for brain injury medicine

- Sleep is disturbed in persons with mTBI

- The construct of insomnia in this population is complex

- The question of whether insomnia is the cause, the consequence, or develops on its own after injury as the person ages and more comorbid conditions accumulate, remains to be answered

- Timely and proper differential diagnosis followed by highly specific treatment necessary
Implications for occupational health & safety and rehabilitation

- The effects of a multidisciplinary approach to treatment and rehabilitation of persons with TBI are well documented, however rates of returning to and remaining at work by one-year post injury are still low.

- Prevention efforts are extremely important:
  - Primary (e.g., identification of workplace hazards)
  - Secondary (e.g., screening for sleep dysfunction and other comorbid conditions)
  - Tertiary (e.g., appropriate treatment of wrTBI and associated disorders and safe return to the workplace, with change of job duties if necessary)
Implications for the employer

- In Canada, 1996-2006 saw labour force growth by 21.7%, an estimated half comprising shift workers\(^1\)

- Overall number of workplace injuries reported declined during this period, rate of injury remained constant for shift workers

- This study – ~50% (n=110) workers with head trauma were performing shift work at the time of their injury, higher than reported for the entire Canadian workforce

- New hypotheses – call for comprehensive investigation of the relationship between circadian displacement due to pre-morbid shift work and variables leading to workplace injury and disability

Implications for the insurer

- Insomnia post injury has important implications for health and safety at the workplace; rarely investigated in injured workers.

- Presented studies raise awareness of the range of modifiable insomnia parameters in workers with delayed recovery from mTBI, and highlight a potential link to shift work based on the proportion of shift workers in the study sample.
Implications for aging with TBI at the workplace

- Sleep problems are common in this study sample of middle aged workers with mTBI and may go uninvestigated.

- Age was identified as a covariate for insomnia as well as sleep-related breathing disorder.

- Awareness of one’s own sleep quality and sleep-wake schedule stability and pursuit of investigation by a professional can promote maximal recovery and potentially keep future accidents from occurring at the workplace and beyond.
If you have questions, please contact me at: tatyana.mollayeva@utoronto.ca

THANK YOU