Morning bright light to improve sleep and pain in Veterans with TBI

Miranda M. Lim, MD, PhD
VA Portland Health Care System
Oregon Health & Science University
Sleep disturbances are common in mild TBI.
TBI is associated with increased pain

Balba*, Elliott* et al. 2018, Journal of Clinical Sleep Medicine
Vicious cycle in TBI: Poor sleep and chronic pain
A sleep intervention should improve pain in TBI

TBI → Sleep Disturbances → Increased Pain → Decreased Quality of Life

Sleep Intervention

Improve Sleep  Decrease Pain  Improve Quality of Life
Sleep Intervention: Morning bright light therapy

Non-pharmacological, non-invasive, home-based, portable, cost-effective

Illuminance (lux)
Direct sunlight: up to 100,000 lux
Full daylight (indirect): ~10,000 lux
Overcast day: ~1,000 lux
Office lighting: ~500 lux
Full moon on a clear night: 1 lux
Morning bright light: Mechanism of action

Adapted from Lockley et al. Current Biology, 2006
# Experimental Design

<table>
<thead>
<tr>
<th>Day 1</th>
<th>1 week</th>
<th>4 weeks</th>
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<tbody>
<tr>
<td>Consent</td>
<td>Baseline</td>
<td>MBLT x 60 min</td>
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- **Day 1**: Consent
- **1 week**: Baseline
- **4 weeks**: MBLT x 60 min

*Start morning bright light therapy*

**Surveys**
- Day 1: Actiwatch
- 1 week: Return actiwatch
Use for 60 minutes before 12 pm in the kitchen, bedroom, or bathroom.

Watch is facing lightbox

Light is not shining directly into eyes

Less than 2 feet
Outcome Measures

Surveys pre- and post-lightbox

Sleep disturbances (ISI and FOSQ-10)
Pain (NIH PROMIS pain intensity and pain interference)
Post-concussive symptom severity (NSI)
PTSD symptom severity (PCL-5)
Depression (PHQ-9)
Emotional-distress anxiety (EDA)
Quality of life (WHO-DAS 2.0)

Actigraphy

Bedtimes/Waketimes
Total sleep time (TST)
Wake after sleep onset (WASO)
Sleep latency (time to fall asleep)
Sleep efficiency (time in bed divided by time asleep)
Mid-sleep time (time corresponding to 50% of subjects sleep period)
Actigraphic evidence of sleep and light box usage

Sleep period

light box use

Actiwatch usage (days/week)
High adherence to light box

Lightbox usage (days/week)
High agreement between objective and subjective sleep measures

<table>
<thead>
<tr>
<th></th>
<th>Wake</th>
<th>Sleep</th>
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<tbody>
<tr>
<td>Wake</td>
<td><strong>WW</strong></td>
<td>WS</td>
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<tr>
<td>Sleep</td>
<td>SW</td>
<td><strong>SS</strong></td>
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Agreement = WW + SS

High agreement between objective and subjective sleep measures
Improved self-reported sleep following MBLT in Veterans with TBI

Insomnia severity index
7 questions; 0-28 range; higher = worse insomnia

Functional outcomes of sleep questionnaire
11 questions; 5-20 range; higher = better outcomes

* P < 0.05 compared to baseline, two-tail paired t-test
Actigraphy Outcomes

Bedtimes & waketimes
Self-report: Prefer earlier bedtimes and waketimes

Less variance in bedtimes/waketimes across days

Representative subject
Actigraphy Outcomes

Bedtimes & waketimes: Earlier, less variance

Mid-sleep time
Shifted ~45 minutes earlier
Actigraphy Outcomes

Bedtimes & waketimes: Earlier, less variance

Mid-sleep time: Shift earlier ~45 min

Total sleep time
Increased by ~77 min (~20%)
Actigraphy Outcomes

Bedtimes & waketimes: Earlier, less variance

Mid-sleep time: Shift earlier ~45 min

Total sleep time: Increased ~20%

WASO
Decreased by ~7 min (~25%)
Actigraphy Outcomes

Bedtimes & waketimes: **Earlier, less variance**

Mid-sleep time: **Shift earlier ~45 min**

Total sleep time: **Increased ~20%**

WASO: **Decreased by ~25%**

Sleep efficiency
Increased by ~8 min (~10%)

*Representative subject*
Actigraphy Outcomes

Bedtimes & waketimes: Earlier, less variance

Mid-sleep time: Shift earlier ~45 min

Total sleep time: Increased ~20%

WASO: Decreased by ~25%

Sleep efficiency: Increased by ~10%

Sleep latency
Decreased by ~11 min (~24%)
Improved sleep quality not simply due to improved sleep hygiene from MBLT

Sleep Hygiene Index
13 questions; 0-52 range; higher = worse sleep hygiene
Improved pain interference (but not intensity) following MBLT

NIH PROMIS
Pain Interference (4 questions; 0-20 range; higher = worse interference)
Pain Intensity (3 questions; 0-15 range; higher = worse pain)

* P < 0.05 compared to baseline, two-tail paired t-test
Improved post-concussive and PTSD symptoms following MBLT in Veterans with TBI

Neurobehavioral Symptom Inventory (post-concussive symptom severity)
22 questions; 0-88 range; higher = worse outcomes

PTSD Checklist (PTSD symptom severity)
20 questions; 0-80 range; higher = worse outcomes

* P < 0.05 compared to baseline, two-tail paired t-test
Improved depression and emotional regulation following MBLT in Veterans with TBI

Patient Health Questionnaire (depression symptom severity)
9 questions; 0-27 range; higher = worse depression

NIH PROMIS Emotional-Distress Anxiety
4 questions; 0-20 range; higher = worse outcomes
Improved quality of life following MBLT in Veterans with TBI

World Health Organization Disability Scale 2.0
(12 questions; 0-100%; higher = worse quality of life in activities of daily living)
Conclusions and Future Directions

Preliminary data suggest MBLT to be effective for:

1. Improving sleep quality in Veterans with TBI
2. Reducing pain interference in Veterans with TBI
3. Improving quality of life in Veterans with TBI

Continue data collection and analysis:

1. Stratify subjects based on trauma history (i.e., TBI, PTSD, and TBI+PTSD)
2. Consider potential moderators

Future work should include:

1. A placebo control device; dose response of MBLT
2. Objectively determined measures of pain (e.g., pressure algometry, conditioned pain modulation, etc.)
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