USING FEEDBACK FROM NATURALISTIC DRIVING TO IMPROVE TREATMENT ADHERENCE IN DRIVERS WITH OBSTRUCTIVE SLEEP APNEA

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Outline

• Introduction
  – Broad Study, Pilot Clinical Trial
  – OSA, CPAP, OSA and Driving

• Methods
  – Subjects
  – Study Timeline
  – CPAP, Actigraphy & Driving Monitoring
  – Intervention
    • Overview, Outline, Data Review

• Results
  – CPAP Across Study
  – Short Term Effect & Summary

• Discussion
  – Overall Trends
  – Intervention Effect
  – Future Directions & Analyses
Introduction: Broad Study

• What we know
  – As a group, people with OSA are at an increased risk for unsafe driving
  – CPAP is the standard treatment and is notorious for non-compliance

• Goals
  – Improve driving safety
    • Determine the dose response relationship between CPAP usage and safe driving
    • (n=130)
Goal

- Increase CPAP usage through a feedback intervention
  - Motivate an increase in CPAP usage through sufficient feedback on driving behavior, sleep hygiene, OSA and cognitive performance
  - (n=60)
Introduction: Obstructive Sleep Apnea (OSA)

- OSA is a disorder in which an individual briefly stops breathing during sleep followed by a short awakening.
- Leads to interrupted sleep patterns and often drowsiness.
- Risk factor for chronic neurological impairment.

Date: Tuesday, June 18, 2013
Introduction: Continuous Positive Airway Pressure (CPAP)

- CPAP is the standard treatment for OSA
- Usage is easily monitored
Introduction: OSA and Driving

• The work of Tregear et al in 2009 shows individuals with OSA are at an increased risk for a motor vehicle crash
  – 95% CI for RR: 1.21 to 4.89

• OSA → Poor sleep → Less alert → Poor driving
Methods: Subjects

- 75 subjects with OSA
- Pilot clinical trial (60 randomized OSA)
  - 30 OSA to not receive the intervention
  - 30 OSA to receive individualized educational intervention
  - 11 OSA in the intervention have completed the study
Methods: Study Timeline

Pre-CPAP

- Driving & Activity Data

- CPAP Data

- OSA

- .5 Months
  - Begin CPAP

- 3 Months
  - Intervention

- 6 Months
  - Study Complete
Methods: Study Timeline
Post-CPAP

Begin CPAP  | 3 Months Intervention  | 6 Months Study Complete

.5 Months Begin CPAP

OSA

Driving & Activity Data
CPAP Data
Methods: Study Timeline
Post-Intervention

Driving & Activity Data

CPAP Data

OSA

.5 Months Begin CPAP

3 Months Intervention

6 Months Study Complete

Date: Tuesday, June 18, 2013
Methods: CPAP Monitoring

- CPAP: Integrated microprocessors
  - Nightly mask-on times and durations
  - Smart cards, EncoreAnywhere™
  - Replaced monthly

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Methods: Actigraphy & Driving Monitoring

- **Actigraphy**
  - Actigraphy watches worn by subjects (Respironics, Inc.)
    - Ambient light
    - Activity levels (movement)

- **Driving**
  - Electronic
  - GPS outputs
  - Video

- Results of driving monitoring are not used as an outcome, but as feedback for the intervention (in this paper)
Methods: Intervention Overview

• Purpose
  – Increase CPAP usage by linking it to driving performance
  – Increased CPAP usage → Higher quality sleep → Safer driving

• Design
  – Based on scientific principles of rehabilitation designed and given by a neuropsychologist

• Individually-tailored feedback
  – OSA, CPAP usage, activity level (including during sleep), cognitive test performances, driving safety before and after CPAP treatment
  – Using driving errors as feedback to encourage CPAP usage to prevent errors

• General information
  – Risks associated with untreated OSA, sleep hygiene recommendations, impact of poor sleep on driving safety
Methods: Intervention Outline

• 45-60 minutes with neuropsychologist
• Spouses encouraged
• Sequence of events
  1. Study purpose and subject’s role reviewed
  2. Data reviewed (individually tailored)
  3. Subject asks questions and asked to summarize main points
  4. Given handouts on OSA and PAP, sleep hygiene, and the risks of drowsy driving

Date: Tuesday, June 18, 2013
Methods: Data Reviewed

- CPAP usage
- Actigraphy data
- Driving video clips
- Apnea Hypopnea Index
- Neuropsychological test performances
Methods: Actigraphy Data

Pre-CPAP

Monday
1/14/2013
(DAY 12)

Post-CPAP

Wednesday
2/27/2013
(DAY 8)
Methods: Driving Data

Pre-CPAP
Unsafe Driving

Pre-CPAP
Drowsy Driving

Post-CPAP
Alert Driving
Results: CPAP Across Study

Average Minutes Used VS Week of Study

Average amount used a night over specific week (min)

Subject's week of study (week)

Date: Tuesday, June 18, 2013

4 hours (240 min)
Results: Short Term Effect

Minutes CPAP Used per Night

Day of Intervention

Amount CPAP used (min)

Night around intervention (day)

Date: Tuesday, June 18, 2013
## Results: Short Term Intervention Effect Summary

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<tr>
<th>Subject Age (years)</th>
<th>Average CPAP usage a night for the week before (min)</th>
<th>Average CPAP usage a night for the week after (min)</th>
<th>Difference between week before and after (min)</th>
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**Overall Difference**
- +17 min

**Paired T-Test (n=11)**
- p=.214

**Same Trend (n=30)**
- p=.037
Discussion: Overall Trends

- Subjects tended to maintain or decrease CPAP usage
  - Mask discomfort, noise, decreased intimacy
  - Some compliant subjects have days with low or zero CPAP usage
Discussion: Intervention Effects

Average Minutes Used VS Week of Around Intervention

Date: Tuesday, June 18, 2013
Discussion: End of Pilot Intervention Analysis (1)

• Upon study completion, we will test whether the feedback intervention improved CPAP adherence, presumably leading to safer driving in OSA
  – Compare the intervention and non-intervention OSA subjects on the difference in average CPAP usage before and after the intervention or analogous date
Discussion: End of Pilot Intervention Analysis (2)

• Upon study completion, we will test if the positive short term effect of the intervention is maintained, resulting in a lasting increase in CPAP adherence
  – Update the short term effect analysis with full data and also analyze long term intervention effect
Discussion: Pilot Intervention

Novelty

• The novel usage of on-road driving outcome measures as a way to motivate an improvement in health and safety related behaviors is a unique aspect of the intervention.
Discussion: Future of Broader Study

• Discover which on-the-road outcome measures index OSA diagnosis and CPAP treatment effects

• You can learn about other study aspects from
  – Lixi Yu: *Effects of Environmental Factors on Naturalistic Driving in Obstructive Sleep Apnea*
  – Dr. Nazan Aksan: *Can Intermittent Video Sampling Capture Individual Differences in Naturalistic Driving?*
Acknowledgments

• Thanks to the subjects
• Thanks to the Research Assistants
• Study supported by NIH R01 HL091917
References


5. Weaver TE; Maislin G; Dinges DF et al. (2007). Relationship between hours of CPAP use and achieving normal levels of sleepiness and daily functioning. *SLEEP*, 30(6), 711-719.

6. Pictures:
   a. [http://americanindian.net/sleeplinks.html](http://americanindian.net/sleeplinks.html) (Slide 2)
Thank You!