Sleep Sensors for Older Adults Residing in a Dementia Special Care Unit: Feasibility and Preliminary Sleep Assessment Efficacy

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Why investigate sleep on a SCU?

- Alzheimer’s disease (AD) is a neurodegenerative disorder and the most common form for dementia
  - Approximately every 60 seconds someone in the U.S. develops AD
  - 5.2 million Americans have AD in 2013
  - 16 million Americans by 2050 (Alzheimer’s Association, 2013)

- The majority of people with dementia will eventually reside in a nursing home (Smith, Kokmen, & O’Brien, 2000)
  - Sleep disturbances contribute to nursing home placement (Pollack & Perlick, 1991)
How does sleep impact AD?

- Sleep disturbances are common in AD
  - Impacts cognitive and physical functioning (Dauvilliers, 2007)

- Poor sleep leads to other health problems (Cricco, Simonsick & Foley, 2001; Brassington, King & Bliwise, 2000; Manabe, Matsui, Yamaya et al., 2000)
  - Predictor of:
    - Cognitive decline
    - Falls
    - Increased 2-year mortality
What is a common approach to SCU sleep assessment?

- Actigraphic measured wrist activity is a wearable sensor
  - Obtains sleep data among nursing home residents with dementia but this technology presents challenges in assessment

- Assessing longitudinal sleep data among older adults with moderate to severe dementia presents several methodological challenges
  - High incidents of neuropsychiatric symptomatology
What is the limitation of the actigraph technology?

- Active technology
  - On person or wearable

- Advances in sensor technology and data processing in ballistocardiography-based system enable passive measurement of sleep in older adults
  - Compliance
  - Safety
Our approach to sleep assessment?

- Technological and data processing advances
  - Improve quality of life and overall wellness by tracking activities of daily living (ADLs) and key conditions (Alwan et al., 2006; Wang et al., 2009; Zhou et al., 2009)

- Recording physiological data in real-life situations could be particularly useful
  - Identification and management of chronic health conditions or problems (Korhonen, Parkka & Van Gils, 2003)
Study Technology

- Healthsense® WellAware® Non-invasive Analysis of Physiological Signals sleep analysis system (NAPS; Healthsense, 2014)
  - Passive (Edge, Taylor, Dewbury & Groves, 2000)
  - Unobtrusive system that collects sleep data from older adults in their environment (Hensel, Demiris & Courtney, 2006)
Healthsense WellAware
Systems sleep sensor network

- Bed and motion sensor
- NAPS bedbox
- Data manager that transmits sleep data via wireless broadband
NAPS Key Sleep Areas

- Sleep disruptions
  - Restless

- Rest efficiency
  - Restful

- Rest continuity
  - Length of restful periods

- These sleep area factors infer, through continuous data collection and learning, whether a resident experiences *healthful sleep hygiene*, for either a single night or a defined period of time.
Present Research

- No known study has examined the possibility and usefulness of installing the NAPS system on a SCU for memory impaired older adults.

Purpose

- Investigate the feasibility and preliminary efficacy of installing the NAPS system on a SCU for older adults with moderate to severe dementia.
  - Feasibility
  - Relationships among health functioning and sleep
Method

Participants

- 10 older adults aged 68 to 95 years (56% of SCU)

Procedure:

- Sleep sensor data (efficiency, disruptions, continuity) continuously were collected from December 6th, 2012 to February 6th, 2013
  - variance

- Health (BMI) and cognitive/mood functioning data (PHQ-9, BIMS, FAST) were collected at baseline from clinical record

- Sleep and neuropsychiatric assessment data (PSQI & NPI-NH) were collected at baseline, posttest at one month, and follow up at two months
SCU bedroom installation
Statistical Analyses

- One sample Wilcoxon Sign Rank Test to test sleep/wake ground truth (Pickles, 1995)

- Robust Statistical procedures (Erceg-Hurn & Mirosevich, 2008)
  - Modern non-parametric statistics (Higgins, 2004)
  - Bootstrap resampling (Efron & Tibshirani, 1993)

- Spearman Correlations using Bootstrap resampling procedures to test for health and sleep associations
  - 10,000 resamples to produce robust 95% CI’s to increase the pilot’s power
### Characteristics of Participants (N = 10)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
<th>%</th>
<th>M (SD)</th>
<th>BCa 95% CI</th>
<th>Mdn</th>
<th>Range</th>
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<td>(78.50, 89.90)</td>
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<td>(415.00, 1760.53)</td>
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Preliminary Findings

➢ No technology or human factor concerns regarding the NAPS System were reported

  o One instance of system-wide equipment issues over the course of the 63-day study (1.6%)

  o 70% double-occupancy bedroom ($n = 7$)

➢ Significant relationships among health status and sleep
Preliminary Findings

- Subjective sleep assessment (PSQI) was reliable but not valid

Month 1
- Staff subjective *bedtime* estimates ($Mdn = 8:30p$) were significantly different from sensor estimates ($Mdn = 7:52p$)

- Subjective *wake time* estimates ($Mdn = 6:30a$) and sensor wake time estimates ($Mdn = 6:41a$) were significantly different

Month 2
- Staff subjective *bedtime* estimates ($Mdn = 7:30p$) were significantly different from sensor estimates ($Mdn = 8:15p$)

- Subjective *wake time* estimates ($Mdn = 6:07a$) and sensor wake time estimates ($Mdn = 7:36a$) were significantly different
## Associations with Sleep Sensor Data

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<th>2</th>
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<th>4</th>
<th>5</th>
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<td>ns</td>
<td>.63 [.36, .89]</td>
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<td>.97** [.77, 1.00]</td>
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<td>.83** [.39, 1.00]</td>
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<td>.46 [.00, .77]</td>
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</table>
Why is the NAPS system feasible?

- Passive and unobtrusive nature of the technology
- Negligible environmental impact
- Improved precision of sleep
  - Ground truth
Why the relationships?

- Cognition, weight, mood and sleep
- AD stage and neuropsychiatric symptoms
- Future research required to replicate and systematically evaluate these possibilities
Conclusions

- Feasible to install the NAPS system on a SCU for older adults with moderate to severe dementia

- Health status and sleep variability are important “vital signs”

- Objective sleep assessment is possible