Assessment of a Wireless Dry Headband Technology for Automatic Sleep Monitoring

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Background and Specific Aim:

The development and validation of low cost, easy to use, portable sleep recording devices with algorithms to distinguish between sleep stages and wakefulness, has important implications for sleep medicine and research.

A new automated system has been developed for assessing sleep. The system uses a headband with a single bi-polar dry fabric sensor that wirelessly transmits data to a base station. A neural network then automatically stages the data into Wake, Light (Stages 1 and 2), Deep (Stages 3 and 4), and REM.

The aim of this study was to evaluate the automated system against actigraphy and human scored polysomnography (PSG) in discriminating stages of sleep and wakefulness.

Methods:

Participants:

• 10 adults (4 female) • 33.7 years old (± 10.7, SD) • No sleep complaints

Study Protocol:

- Sleep in the laboratory at the participant's habitual bedtime
- Concurrent measurement of PSG, automated wireless system and actigraphy
- PSG data collected with Cadwell Easy II PSG, sampled at 200 samples per second
- Wireless system data were sampled at 128 samples per second
- Actigraphy data were collected on a Mini-Mitter Actiwatch 64, epoch length set at 30 seconds
- Sleep records were independently scored by 2 trained technicians according to Rechtschaffen & Kales
- Sleep records were scored automatically by the wireless system via its neural network
- Actigraphy records were scored automatically by Actiware 5.0 software at medium wake threshold sensitivity (wake threshold value of 40 activity counts)
- 6 subjects contributed two nights of recordings and 4 subjects one night, resulting in 16 total records
- Inter-rater agreement was performed on summary statistics of sleep parameters and on a 30-second epoch-by-epoch basis for agreement/disagreement of sleep/wake state decisions

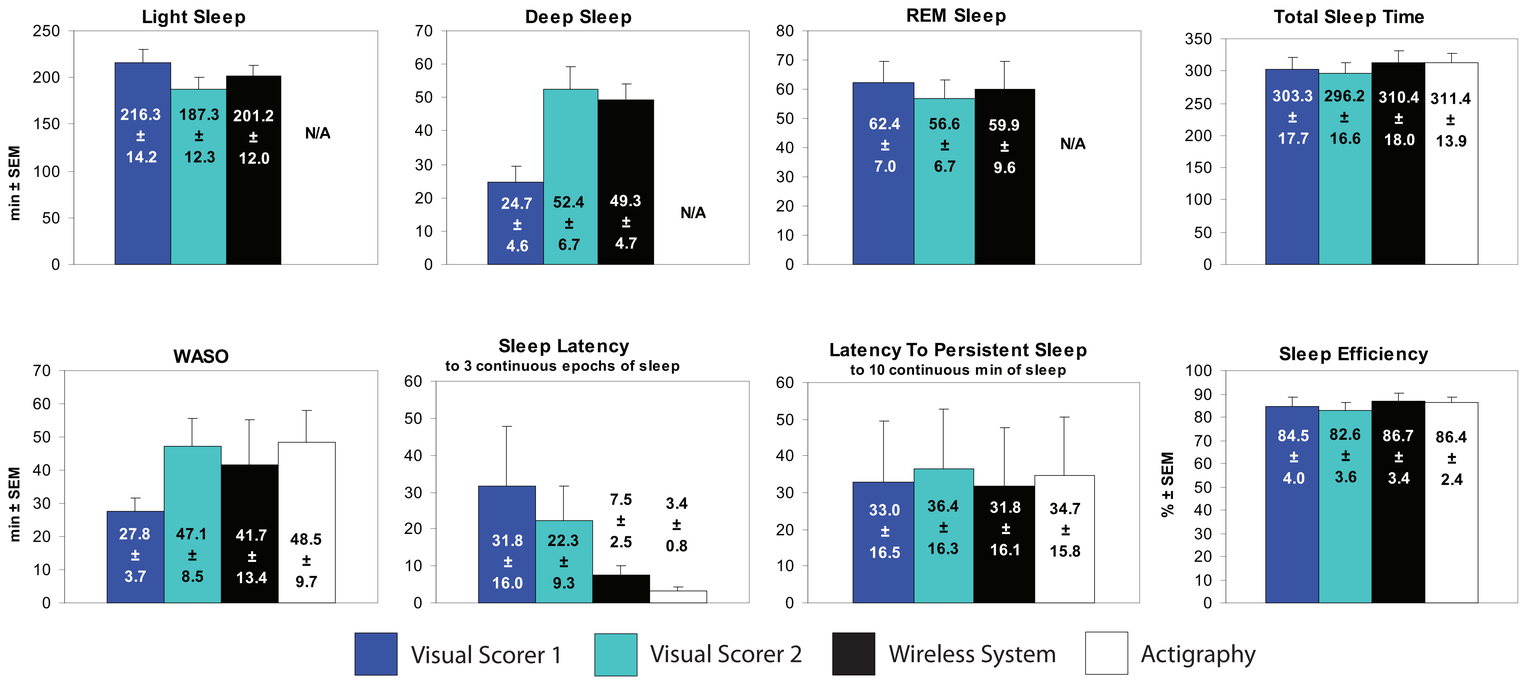
Results:

Average epoch-by-epoch agreement and Cohen's Kappa statistic for effect size was calculated for each comparison.

- **Inter-rater agreement of sleep stages between the two visual scorers was high**
- **Agreement of sleep stages between the wireless system and the visual scorers was moderate**
- **Agreement of sleep/wake for actigraphy & the wireless system against the scorers was moderate to high**

Inter-rater Agreement		% Agreement	Cohen's Kappa
Wake/Light/Deep/REM			
Visual Scorer 1	vs. Visual Scorer 2	84	0.75
Wireless System	vs. Visual Scorer 1	75	0.59
Wireless System	vs. Visual Scorer 2	73	0.57
Sleep/Wake			
Visual Scorer 1	vs. Visual Scorer 2	95	0.82
Wireless System	vs. Visual Scorer 1	91	0.63
Wireless System	vs. Visual Scorer 2	88	0.57
Actigraphy	vs. Visual Scorer 1	85	0.41
Actigraphy	vs. Visual Scorer 2	85	0.43

- **Most sleep stage summary measures were similar for the scorers and the wireless system**
- **The ability for actigraphy to distinguish between sleep and wakefulness was consistent with prior literature**



Conclusion:

The wireless system shows promise as an affordable, portable, easy to use, sleep monitoring technology that has advantages over existing ambulatory technologies to monitor sleep. Ongoing and additional data collection and analysis are needed to further evaluate and validate the wireless system.

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