THE UNIVERSITY OF ARIZONA College of Medicine Phoenix

Identification of Apnea Events Using a Chest-worn Physical Activity Monitor

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Study Aim

Use the Zephyr BioHarness 3 (BH3) to identify apnea events in patients suspected of obstructive sleep apnea (OSA)

Figure 1. Image of Zephyr BioHarness 3

Introduction

- OSA is an underdiagnosed risk factor for cardiovascular morbidity and mortality
- Current gold standard for OSA diagnosis is laboratory-based PSG
- Many patients lack access to PSG
- The BH3 is a chest-worn physical activity monitor that records movement, heart rate (HR), electrocardiogram (ECG), and respiratory rate (RR) data in real-time
- Due to physiologic monitoring capabilities, the BH3 may be a useful portable sleep monitor for patients suspected of OSA

Eligibility Criteria

- Age 35-60 years
- BMI 27-35 kg/m^2
- No previous continuous positive airway pressure therapy
- No comorbid neurologic or sleep disorder

Methods

- Patients recruited from Sleep Disorders Center at Mayo Clinic in Phoenix, AZ
- Patients undergoing single-night PSG were fitted with BH3 after being fitted for PSG
- BH3 and PSG data were collected concurrently
- PSG scored by licensed, registered sleep technician

Measures

- Apnea events identified on PSG as scored by sleep technician according to American Academy of Sleep Medicine Scoring Manual
- HR, RR, ECG, movement recorded by BH3

Analysis

BH3 data was analyzed in 10-second windows using 3 methods:

1. Support vector machine (SVM), logistic regression, and neural networks (Table 1)
2. Differences in mean, median, and variance between 10-second windows (Table 2)
3. 5-dimensional phase-space transformation using window size = 5 seconds and τ = 70 (Table 3)

Study Sample

Gender	
Men	10
Women	10
Average Age	58.0 ± 7.3 years
Average BMI	29.6 ± 3.0 kg/m^2
Average neck circumference	38.4 ± 3 cm
Treated for HTN	6
Average STOP-Bang	4.6 ±1.9
Average ESS	8.0 ± 5.4

BMI = body mass index. HTN = hypertension. ESS = Epworth sleepiness scale. STOP-Bang = STOP-Bang questionnaire for OSA

Table 1

	PSG Apnea	PSG Not Apnea
BH3 Apnea	15749	90917
BH3 Not Apnea	4880	152751
Sensitivity	*76.0 ± 0.3%*	
Specificity	*62.7 ± 0.2%*	
Accuracy	*63.7 ± 0.1%*	

Table 1. Apnea identification by SVM, logistic regression, and neural network applied to 10-second windows of BH3 data. PSG = polysomnography. BH3 = Zephyr BioHarness 3

Table 2

	PSG Apnea	PSG Not Apnea
BH3 Apnea	14714	74624
BH3 Not Apnea	5645	169044
Sensitivity	*72.3 ± 0.3%*	
Specificity	*69.4 ± 0.1%*	
Accuracy	*69.6 ± 0.1%*	

Table 2. Apnea identification by differences in mean, median, and variance between 10-second windows of BH3 data. PSG = polysomnography. BH3 = Zephyr BioHarness 3

Table 3

	PSG Apnea	PSG Not Apnea
BH3 Apnea	15262	92853
BH3 Not Apnea	4587	327974
Sensitivity	*76.9 ± 0.3%*	
Specificity	*77.9 ± 0.1%*	
Accuracy	*77.9 ± 0.1%*	

Table 3. Apnea identification via 5-dimensional phase-space transformation of BH3 data with window size = 5 seconds τ = 70. PSG = polysomnography. BH3 = Zephyr BioHarness 3

Discussion

- OSA will continually become a larger public health concern as obesity prevalence increases
- Access to PSG does not currently meet patient demand or public health needs
- Portable sleep monitoring may become a valuable tool, especially for patients who lack adequate access to timely PSG
- Portable sleep monitoring allows for multiple nights of data collection in a patient's typical sleeping environment outside of the PSG lab
- Despite small study sample, the BH3 and PSG collect large amounts of data pertaining to the night of sleep being studied
- The most accurate and clinically useful method used in this study was 5-dimensional phase-space transformation of BH3 data

Conclusions

- The BH3 shows promise as a portable sleep monitor for patients suspected of OSA
- Future studies using larger sample sizes of patients and multiple nights of BH3 data may clarify the BH3's clinical utility in patients suspected of OSA

Acknowledgments

- Honeybee Project for funding
- Bernie Miller and the staff at the Sleep Disorders Center at Mayo Clinic Hospital in Phoenix, AZ for their assistance and willingness to work on this project