ECG-Based Sleep Architecture Evaluation in Children

Anda Baharav[1,2], Shuli Eyal[2], Yair D. Fuxman[2], Clement Cahan[1]
(1) Shaare Zedek Medical Center, Sleep Disorders Clinic, Jerusalem, Israel; (2) HypnoCore, Yehud, Israel;

Introduction

A whole night sleep study in a lab inherently removes a child from his natural sleep environment and requires multiple sensors on the head, face and body. This influences sleep quality and architecture, is cumbersome for both patient and technician.

Partial studies in the home ease the discomfort, yet they have the great limitation of lacking information regarding sleep architecture, mainly REM presence and arousals.

An ECG-based method to score sleep in adults has been validated.[1,2] Our objective is to estimate the validity of this method in a pediatric population.

Methods

- **42 complete PSG recordings were collected of pediatric patients referred to the Shaare Zedek Sleep Disorders Clinic for suspected apnea.**
  - **Average age 5.5 years old (range 13 months-12.5 years)**
  - **21 female, 21 male.**
- **The recordings were scored according to gold standard criteria by a trained technician, and blindly and independently by the HC1000P sleep diagnostic system, results were then compared for agreement.**
- **HC1000P allows sleep staging based on HRV analysis in the time frequency domains, as a measure of fluctuations of the autonomic cardiovascular control with different sleep/wake states, while arousals, actually autonomic arousals are evaluated from accelerations of the heart rate in the time domain.**

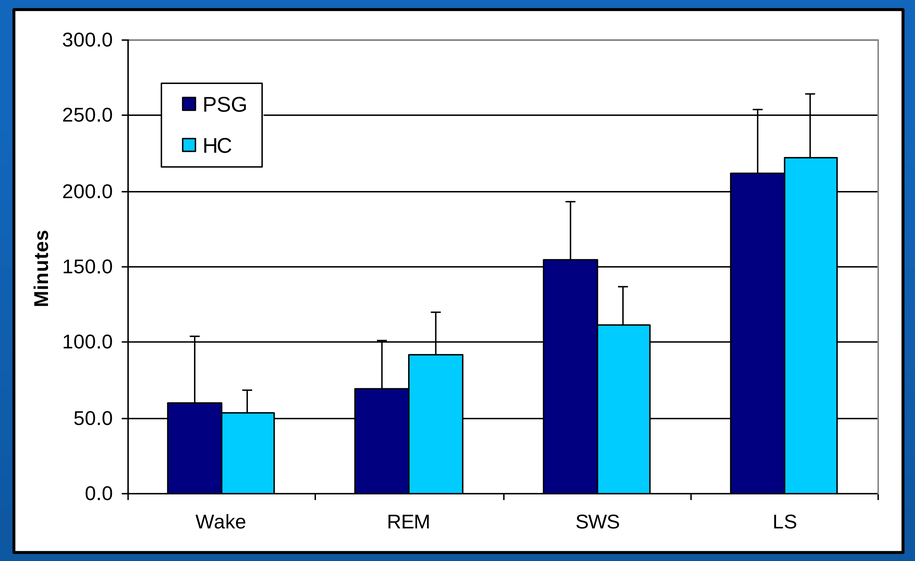

Fig 1: Comparison of sleep stage duration in minutes by manual scoring (PSG) and automated scoring by HC1000P (HC), mean+SD.

Results

- ✓**Results of sleep staging by the automated system HC1000P correlated well with results of manual scoring (see Figure 1).**
  - ✓**Wake was 60.4±43.3 minutes by manual scoring, 53.1±15.0 by HC1000P.**
  - ✓**REM was 69.7±31.2 minutes by manual scoring, 91.9±28.2 minutes by HC1000P**
  - ✓**Slow Wave Sleep 154±38.8 minutes by manual scoring, 112.0±25.3 minutes by HC1000P**
  - ✓**Light Sleep was 211.6±42.2, 222.3±42.2 by manual scoring and HC1000P respectively.**
  - ✓**Epoch by epoch agreement in determining wake/sleep was 87%. Agreement in determining NREM/REM was 80%.**

Conclusions

ECG-based estimation of sleep architecture may be used as an important aid in sleep testing in children, allowing for reliable and cost-effective home sleep studies by adding information regarding sleep efficiency and REM presence to the information obtained from direct measurements of respiratory parameters.

References

1. Baharav, A., S. Kotagal, V. Gibbons, B.K. Rubin, G. Pratt, J. Karin, and S. Akselrod, *Fluctuations in autonomic nervous activity during sleep displayed by power spectrum analysis of heart rate variability.* Neurology, 1995. 45(6): p. 1183-7.
2. Decker, M.J., S. Eyal, Z. Shinar, Y. Fuxman, C. Cahan, W.C. Reeves, and A. Baharav, *Validation of ECG-derived sleep architecture and ventilation in sleep apnea and chronic fatigue syndrome.* Sleep Breath, 2009.