

## Detecting volatility clustering of heartbeat dynamics: A novel approach for patients with obstructive sleep apnea

Yuo-Hsien Shiau, Jia-Hong Sie and Sai-Ping Li  
National Chengchi University, Taiwan

It is known that obstructive sleep apnea (OSA) is the repeated, temporary cessation of breathing during sleep caused by intermittent airway obstruction, and OSA is considered as an independent risk factor for hypertension. The physiological mechanisms leading to cardiovascular disease in OSA are complex and not fully understood. However, it is believed that changes of the cardiac autonomic regulation are regarded to be involved in the development of cardiovascular disease in OSA patients. In this study, we report a novel method for detecting volatility clustering of heartbeat dynamics, which can well reflect the non-stationary physiologic process for OSA patients during sleep. Three groups of subjects (publicly released in PhysioNet) were considered in this study, where apnea, borderline apnea, and normal subjects were classified according to the number of apnea and hypopnea happened during sleep. Based upon our results, the number of apnea events have a significantly influence on the clustering degree of large volatility embedded in heartbeat dynamics. As expected, detecting volatility clustering provides significant differentiations for apnea, borderline apnea, and normal subjects through Games-Howell post hoc test. Therefore, the receiver operating characteristic curve between apnea and normal groups reflects both high sensitivity and specificity, where the AUC value can be up to 0.76. The underlying meaning of volatility clustering in heartbeat dynamics should be strongly related to changes of the cardiac autonomic regulation, where sleep stages and apnea events are two main factors. Although our method cannot replace the target indices that are derived from the direct recording of respiration, e.g., apnea-hypopnea index and disordered breathing, clinical applications can be expected under the consideration of reduction of personal costs. This work was partially supported by the National Science Council of the Republic of China (Taiwan) under Contract Nos. NSC 101-2311-M-004-002-MY3.

### Biography

Yuo-Hsien Shiau had completed his Ph.D. in 1995 from National Taiwan University and postdoctoral studies from Institute of Physics, Academia Sinica. He is the Associate Professor of Graduate Institute of Applied Physics, National Chengchi University. He has published more than 35 papers in reputed journals including medicine, optics, fluids, and semiconductor physics. His research interest is complex systems.

[yhshiau@nccu.edu.tw](mailto:yhshiau@nccu.edu.tw)