List of talk topics (Thomas Penzel)

The future of sleep medicine - challenges for biomedical engineering

Summary:

Sleep disorders are found to be more prevalent than previously realized. This may be a consequence of a modern society which optimizes work and social activities up to the edge. In order to investigate normal and disturbed sleep, we record biosignals both in the sleep laboratory and at home. Signals may be recorded directly, such as EEG, EOG, EMG from the head of the sleeping person, or indirectly, such as ECG, heart rate, respiration, pulse wave. Signals may be recorded with little contact or no contact systems such as actigraphy, body movement, bed sensors or bedside radiofrequency sensors. Some signals are new in sleep research and require new technology and analysis concepts. Always biosignals were recorded with an appropriate time and amplitude resolution, and then we derive physiological functions. We can identify wakefulness and sleep, we can derive details about sleep, such as light sleep, deep sleep, and REM sleep, arousals and sleep fragmentation. Not only classical methods in the time and frequency domain are used, but also more recent methods using statistical approaches are applied. This allows recognizing normal and restorative sleep and identifying sleep disorders as well. Some sleep disorders imply cardiovascular consequences and require treatment. Sleep disordered breathing is the disorder with most cardiovascular consequences. Many diagnostic tools like wearbles focus on this group of disorders. Diagnostic methods and perspectives are presented in this communication.

Cardiorespiratory coupling: respiration, heartrate, and ECG during sleep

Summary:

The cardiac component of cardio-respiratory polysomnography is covered by ECG and heart rate recordings. However their evaluation is often underrepresented in summarizing reports. As complements to EEG, EOG, and EMG, these signals provide diagnostic information for autonomic nervous activity during sleep. This review presents major methodological developments in sleep research regarding heart rate, ECG and cardio-respiratory couplings in a chronological (historical) sequence. It presents physiological and pathophysiological insights related to sleep medicine obtained by new technical developments. Recorded nocturnal ECG facilitates conventional heart rate variability analysis, studies of cyclical variations of heart rate, and analysis of ECG waveform. In healthy adults, the autonomous nervous system is regulated in totally different ways during wakefulness, slow-wave sleep, and REM sleep. Analysis of beat-to-beat heart-rate variations with statistical methods enables us to estimate sleep stages based on the differences in autonomic nervous system regulation. Furthermore, up to some degree, it is possible to track transitions from wakefulness to sleep by analysis of heart-rate variations. ECG and heart rate analysis allow assessment of selected sleep disorders as well. Sleep disordered breathing can be detected reliably by studying cyclical variation of heart rate combined with respiration-modulated changes in ECG morphology (amplitude of R wave and T wave).

Pulse wave recording and analysis in sleep apnea

Summary:

Sleep medicine has been an expanding discipline during the last decades. The prevalence of sleep disorders is increasing and sleep centers expand at hospitals and in the private care environment to meet the demands. The reference for diagnosis in sleep centers is polysomnography with an

assessment of all functions and dysfunctions being observed during sleep. However, the number of sleep centers and caregivers in this area is not sufficient. Many new methods for recording sleep and diagnosing sleep disorders have been developed, especially for sleep disordered breathing. Cost-efficient technologies for the initial diagnosis and for follow-up monitoring of treatment are important. The recording of the pulse wave and the analysis of the pulse wave on the finger allows to detect sleep disordered breathing and allows to estimate sleep stages to some extend of precision. One such technique is called peripheral arterial tonometry and is distributed as a validated tool for sleep recording. Based on the analysis of sympathetic tone, REM sleep can be recognized quite well. New algorithms show the ability to distinguish central and obstructive sleep apnea. To evaluate peripheral arterial tone allows to estimate vascular properties even during daytime.