

Quantitative analysis of sleep: Useful in clinical applications?

Prof. Peter Achermann

The EEG is a complex signal and an important brain state indicator (e.g. waking, sleep, seizure). Crucial aspects of the signal may not be recognized by visual inspection of the EEG. The conventional method of sleep scoring is inadequate for quantitative EEG analysis because the definition of sleep stages is based on rather general and arbitrary criteria. Assessment of EEG variables by computer-aided methods of signal analysis, such as spectral analysis (decomposing a signal into its constituent frequency components) is an important method to investigate brain activity and provides complementary information to sleep stages. The fast Fourier transform (FFT) is a widely applied method for obtaining the EEG power density spectra. The spectrogram (i.e. color-coded power spectra) of an entire nights' sleep provides a clear overview of the structure of a sleep recording even if sleep stages have not yet been visually scored. Delta activity (< 4.5 Hz) and spindle frequency activity (12 - 14 Hz) are distinct features of non-REM sleep. They can be identified clearly in the spectrograms. The absence of activity in these frequency bands is a marker of REM sleep. Alpha activity (approx. 10 Hz) may be present during waking prior to sleep onset and in waking episodes during sleep.

In pathology alterations in the EEG compared to healthy subjects are usually clearly visible, e.g. a shift of peaks or a slowing of EEG activity may be observed. For example, in sporadic Creutzfeldt-Jakob disease profound EEG alterations were observed. The typical sleep-cycle related EEG power modulations were absent and sustained high power in the low delta range (< 2 Hz) were prominent. No declining trend of delta activity (1 to 4 Hz) and a complete loss of spindle activity were evident. Similarly, vegetative state patients showed a general slowing of the EEG. Patients appeared to have sleep- and wake-like states, but did not show clear sleep-wake cycles.

Quantitative EEG analysis is a useful tool for differentiating brain activity in health and disease.

Lecture co-financed by the European Union in scope of the European Social Fund