

e.g. sleep spindles and slow waves, based directly upon the classical definition of these structures.

**Results:** We present successful parameterization and automatic detection of delta waves and sleep spindles and also possibility of detection of different events like arousals in all-night EEG sleep data. Apart from the new continuous descriptors of the overnight sleep process, within the same framework are proposed detection of deep sleep stages (based directly upon the classical R&K criteria) with concordance on the level of the inter-expert agreement.

**Conclusions:** Adaptive time-frequency parameterization provides a bridge between the advanced signal processing and the traditional, visual analysis. Proposed paradigm provides description of the major features of sleep EEG in a way compatible with traditional, visual analysis.

## O 109

### A new data acquisition system for monitoring circadian variations of activity and ECG: Technical aspects

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**Aims:** Sleep disturbances are often accompanying somatic, neurologic and psychiatric disorders. But today, they are usually not evaluated quantitatively/objectively, although they may provide useful information about the course of the primary disease, as for example in depressive patients. For this reason, a dedicated data acquisition system has been developed that can be integrated into the clothing of the patient (e.g. into underpants or pyjama) and that allows long-term monitoring of sleep, but also of daytime activity.

**Methods:** The data acquisition system consists of a textile and an electronic module. The textile can be attached to the waistband of standard underpants by means of snap fasteners. It contains 3 rubber electrodes for 1-lead ECG measurements, a temperature sensor and a pocket for taking up the electronic module. The electronic module consists of several circuit boards which are mounted on a flexible metal rack. It contains the following units:

- analog ECG preprocessing
- 2D accelerometer (for measuring the patient's activity)
- digital unit (microprocessor and 128 MB memory)
- accumulators (energy lasts for 5 days of measurements)
- communication unit (Bluetooth link to PC)

The electronics are coated with a foam material in order to protect the electronic components and to enhance the

comfort for the patient. So far, the system has been tested in a clinical setting on 12 patients for periods of 4–12 weeks respectively.

**Results:** As for hardware reliability and robustness the following failures have occurred during the measurements: One electronic module broke mechanically, another broke down due to electrical problems. As for the textile, in one piece two electrodes had to be replaced, one because of a broken cable. As for signal quality, it has been observed that the quality of the ECG signal highly depends on the physical activity of the patient. The more active the patient is, the more motion artefacts are found on the ECG signal. But during sleep, the ECG quality is in general sufficient for the designated calculations of heart rate and heart rate variability (HRV). The time in bed (TIB) as well as the movement time (MT) are clearly identifiable from the accelerometer signal. This will be presented in detail.

**Conclusion:** The reliability and the robustness of the data acquisition system seem to be acceptable for a clinical setting. The integration of the data acquisition system is also perceived as advantageous because it enables discreet and at the same time comfortable measurements. The signal quality of the ECG and the activity measurements meet the requirements. By placing the activity sensor at the patient's trunk, the measurements map the patient's overall activity very reliably. The body temperature signal still seems to be subject to too many external influences. This will be subject to further investigations.

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### The temporal distribution of sawtooth waves at the onset of REM sleep

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**Introduction:** Sawtooth waves (STW) are a typical EEG pattern of REM sleep in the frequency range 2 to 6 cycles per second with a characteristic appearance (slow negative upward phase, followed by a steep positive deflection). The source and function of STW are unknown. STW occur intermittently, frequently in association with REM bursts. STW can also occur in stage 2 sleep just before REM sleep. We studied the temporal distribution of STW before and after the onset of REM sleep.

**Methods:** Polysomnographic (PSG) recordings of 20 subjects (12 w, 8 m, mean age 51.0 years, SD 18.5 years) were analysed. The sample was randomly drawn from our clinical data bank. PSG recordings contained 4 EEG channels (F1-A1, C3-A2, C4-A1, and O2-A2), 2 EOG, 4 EMG, 1 ECG and 3 respiratory channels. In a first step, the last 20 epochs immediately preceding REM and the first twenty epochs into REM sleep were extracted and stored. In a second step, all 30s epochs were subject-wise rearranged