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Symposia, Oral and Poster Presentation
Abstracts

The abstracts have been reviewed by:

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Computerized detection of movement artifacts in polysomnogram data
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Objectives: Human polysomnograms (psgs) consists of a collection of bio-physiological events recorded simultaneously during sleep, potentially creating inter-channel interference issues leading to artifacts that impair psg interpretation. One artifact commonly encountered are excessive patient movement (EPM), arousals, that introduce increased amplitude fluctuations with increased variance and signal drift, making the underlying signal of interest unrecognizable. Although characterization of EPM is simply described the production of these events are not displayed uniformly across subjects and are commonly disproportionate to Non-EPM activity, which emphasizes the importance of establishing a robust detection scheme. To automatically detect EPM activity, we applied the Synthetic Minority Over-Sampling Technique(SMOTE) to EPM and undersampling to Non-EPM, within a supervised classification scheme.

Methods: Two psgs, acquired with Embla N7000 PSG, from separate patients, totaling over 21,600 s, were visually scored for EPM activity. One psg contained frequent EPM activity and another infrequent EPM activity. Electroencephalogram channel C3-A2 was extracted for processing. Data was categorized using a 4 step process. (1) Feature extraction, (2) Feature Selection, (3) Classification and (4) Performance evaluation. Feature extraction was conducted with non-overlapping moving windows of 1 s duration and included features from the time and frequency domains. Feature selection was implemented using the Branch and Bound algorithm. Classification was conducted using SMOTE and a k-nearest neighbor classifier. Performance evaluation included 10-fold cross validation.

Results: Agreement between automated and visual EPM activity labeling depended upon application of SMOTE and amount of EPM activity. Maximum performance was obtained for both data sets (infrequent and frequent EPM activity, respectively) when SMOTE was used (Sensitivity = 79.00 ± 1.46 and 91.20 ± 0.46) in comparison without SMOTE (Sensitivity = 71.56 ± 1.24 and 90.74 ± 2.34). Also, fewer features were required when EPM activity was more frequent (2 vs. 8 features).

Conclusion: SMOTE enhances automated detection of EPM activity, especially in cases of frequent EPM activity. To improve EPM detection, future work will include comparing multiple feature selection algorithms and classifiers. SMOTE improves automated detection of movement artifacts in psgs assisting in development of better tools for automated psg analysis.

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Sleep-wake patterns in vegetative state: 24 h polysomnographic findings in 27 subjects
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Objectives: Despite the occurrence of behavioural states suggesting persistence of sleep in patients in a vegetative state (VS), the real existence of sleep patterns and its meaning with respect to the VS evolution are far from being established. This study is aimed at featuring sleep wake patterns in patients in persistent VS by mean of a 24-h standard Polysomnographic (PSG) monitoring and at correlating the PSG findings with the VS evolution.

Methods: Patients were 27 adults (mean age 52.6 ± 19.4 years, age range 18–81; 18 males) brain injured subjects (anoxic insult in 7 cases, traumatic in 13 and haemorrhagic/ischemic in 7). In all the patients a 24 h PSG was done within a 1–11 month period (mean 3.5 ± 2.3) after the insult. At the time of the PSG monitoring the patients state could be defined as a persistent VS according to standard criteria and their Coma Recovery Scale-revised (CRS-R) was 7.1 ± 3.2. The potential correlation of PSG findings with the VS evolution, in terms of CRS-R score and clinical outcome, within a mean follow up of 16.7 ± 11.0 months was tested.

Results: The application of standard sleep scoring criteria proved to be difficult, with a traditional staging being possible in only a third of the patients. In the remaining cases EEG-polygraph pattern characterized by isolated phasic elements were recognizable. The clinical outcome was: 8 death; 7 Permanent Vegetative State; 9 Minimally Conscious State; 3 Recovery of Consciousness. CRS-R total score at follow up was significantly associated with total CRS-R score at baseline (p = 0.007), patients’ younger age (p = 0.002), a more preserved sleep structure (p = 0.0007) and occurrence of Rapid Eye Movements (REMs) as isolated phasic events or within the context of REM sleep stages (p = 0.004). A better clinical outcome was associated with conventionally scorable NREM and REM sleep stages and occurrence of but isolated REMs (p = 0.0001 and p = 0.001 respectively).

Conclusions: The PSG parameters which prove to correlate with a better clinical outcome are a better global organization of sleep, resulting in the applicability of conventional sleep staging, or at least the presence of REMs. In keeping with current literature data in the field, also the subjects’ age proves to influence the clinical outcome, with younger age being a favorable predictor of a good outcome. Summing up, our data highlight the prognostic value of PSG monitoring of sleep wake patterns in patients in a persistent vegetative state.

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Multi-trial extended subspace-based approach for visually evoked potentials (VEPs) extraction
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Objectives: The extraction of the VEP signal from the brain background noise a challenging issue because of the low SNR values. The conventional method of ensemble averaging (EA) does improve the SNR, but at the expense of longer recording time. On the other hand the recently proposed single-trial subspace-based technique manages to extract the VEPs using single trial but at relatively high failure rate. In this research, we extend the subspace-based techniques to multi-trials in order to reduce the failure rate of the subspace-based techniques and to approach EA performance with less number of trials.

Method: The EEG data is first averaged with limited number of trials (10–15 trials) in order to enhance the SNR to the neighbourhood of ~3 dB. Then the EEG covariance matrix is predefined using Cholesky factorization and linear estimation of the clean signal is performed. The subspace of data covariance matrix is then decomposed into signal subspace and noise subspace. Enhancement is performed by nulling the components in the noise subspace and retaining the components in the signal subspace.

Results: The capability of the proposed technique in extracting the clean VEPs, is assessed and compared with ensemble averaging. In the first experiment the comparison is conducted using artificially generated VEP signals corrupted by colored noise. The capabilities of