Seizure Prediction with Autonomic Measurements versus Intracranial EEG in Patients with Refractory Epilepsy

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Abstracts will be considered for both poster and platform presentations

Epilepsy/Brain metabolism

Introduction: There is resurgent interest in the role played by autonomic dysfunction in seizure generation. Advances in wearable sensors make it convenient to track many autonomic variables in patient populations. The purpose of this study is to assess peri-ictal changes in surrogate measures of autonomic activity in epilepsy patients.

Methods: With IRB approval, three patients admitted for invasive presurgical evaluation using intracranial EEG (iEEG) were monitored. Additional sensors for fronto-central EEG, EKG and submental EMG were applied and variables relevant to autonomic function (AV), specifically electrodermal activity, heart rate, blood volume pulse and skin temperature measured by a wrist-worn device. The mean of each AV was computed in 5-second epochs. Several one hour-long interictal and preictal segments were extracted for analysis: 7 interictal and preictal segments during sleep from patient 1; 6 interictal and preictal segments during sleep, and 8 interictal and 5 preictal segments during wakefulness from patient 2; and 8 interictal and 3 preictal segments during wakefulness from patient 3. Hence two of three patients had either only sleep or only wake data. Sleep and wake data were verified using video-EEG and analyzed separately to minimize the potentially confounding effect of vigilance state. Several electrophysiological variables (EV) were estimated in 5-second epochs from the iEEG in the seizure onset zone, and a naïve Bayes classifier was trained on these features and tested using five-fold cross-validation to determine whether preictal and interictal sleep (or wake) epochs could be distinguished from each other using AV or EV features.

Results: Of 16 EV features, beta power, gamma power (30-45 Hz and 47-75 Hz), line length, and Teager energy were sometimes significantly different for preictal and interictal sleep (or wake) data in each patient (ANOVA: $p < 0.001$). At least one AV was significantly different in each patient for interictal and preictal sleep (or wake) segments ($p < 0.001$). Using AV features, the classifier labeled preictal sleep epochs with 84% sensitivity, 79% specificity, and 64% kappa; and 78%, 80% and 55% respectively for preictal wake epochs. Using EV, the classifier labeled preictal sleep epochs with 69% sensitivity, 64% specificity, and 33% kappa; and 15%, 93% and 10% respectively for preictal wake epochs.
Conclusions: Appreciable preictal vs interictal sleep (or wake) autonomic changes were documented in patients monitored during Phase II presurgical evaluation. This result suggests that autonomic measurements, which can be conveniently measured using noninvasive devices, have some predictive value for epileptic seizures in certain individuals.

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