Outcome Prediction after Cardiac Arrest using Machine Learning and Network Dynamics of Resting-State Electroencephalography

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In the acute stage following cardiac arrest (CA), accurate prognostication of patients' functional recovery is a challenge. The aim of this study is to combine machine learning with spectral and network features of resting-state electroencephalogram (EEG) at 72 hours post injury to predict the functional outcome of comatose patients following CA.

We analyzed the open-source I-CARE database containing 19-channel resting-state EEG of 1020 comatose patients who suffered a CA. Patients' functional recovery was assessed using the *Cerebral Performance Category (CPC)* scale within 6 months after return of spontaneous circulation (ROSC). The training data (n=607) was split into 80% training and 20% cross-validation data. 413 subjects served as the holdout test set. We obtained spectral power using Welch's method and the spectral slope using the FOOOF algorithm in the 1-45 Hz and 30-45 Hz frequency ranges. Signal complexity, fractality, chaoticity and avalanche criticality were calculated. Two scikit-learn random forest models (n_estimators = 6000) were implemented: 1) a classification model for the prediction of good (CPC<3) or poor (CPC≥3) outcome and 2) a regression model for the prediction of the CPC score. The models were evaluated using accuracy, area under the curve (AUC), true positive rate (TPR) and mean absolute error (MAE).

For the prediction of patients' functional outcome, we achieved a cross-validation accuracy of 0.727, AUC of 0.821 and TPR of 0.577. The prediction of the CPC score yielded a MAE of 1.277. Using the holdout test set, our team EEGnition achieved a challenge score (TPR) of 0.45.

Based on the resting-state EEG recordings within 72 hours post ROSC, we were able to predict the functional outcome of comatose patients with an accuracy of 73%. Our results may yield clinically relevant insights into the neurophysiological markers underlying the outcome trajectory of CA patients.