Title: Phenotyping Neuropsychiatric Symptoms Profiles of Alzheimer's Disease Using Cluster Analysis on EEG Power

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Abstract:

Background: There has been an increasing interest in studying electroencephalogram (EEG) as a biomarker of Alzheimer's disease but the association between EEG signals and patients' neuropsychiatric symptoms remains unclear. We studied EEG signals of patients with Alzheimer's disease to explore the associations between patients' neuropsychiatric symptoms and clusters of patients based on their EEG powers.

Methods: A total of 69 patients with mild Alzheimer's disease (the Clinical Dementia Rating = 1) were enrolled and their EEG signals from 19 channels/electrodes were recorded in three sessions for each patient. The EEG power was calculated by Fourier transform for the four frequency bands (beta: 13-40 Hz, alpha: 8-13 Hz, theta: 4-8 Hz, and delta: <4 Hz). We performed K-means cluster analysis on the log-transformed EEG powers (4 frequency bands x 19 channels) to classify the 69 patients into two distinct groups for the three EEG sessions. In each session, both clusters were compared with each other to assess the differences in their behavioral/psychological symptoms in terms of the Neuropsychiatric Inventory (NPI) score.

Results: While EEG band powers were highly consistent across all three sessions before clustering, EEG band powers were different between the two clusters in each session, especially for the delta waves. The delta band powers differed significantly between the two clusters in most channels across the three sessions. Patients' demographics and cognitive function were not different between both clusters. However, their behavioral/psychological symptoms were different between the two clusters classified based on EEG powers. A higher NPI score was associated with the clustering of higher EEG powers.

Conclusion: The present study suggests that EEG power correlates to behavioral and psychological symptoms among patients with mild Alzheimer's disease. The clustering approach of EEG signals may provide a novel and cost-effective method to differentiate the severity of neuropsychiatric symptoms and/or predict the prognosis for Alzheimer's patients.