

The role of quantitative EEG (QEEG) in clinical trials: A methodological review



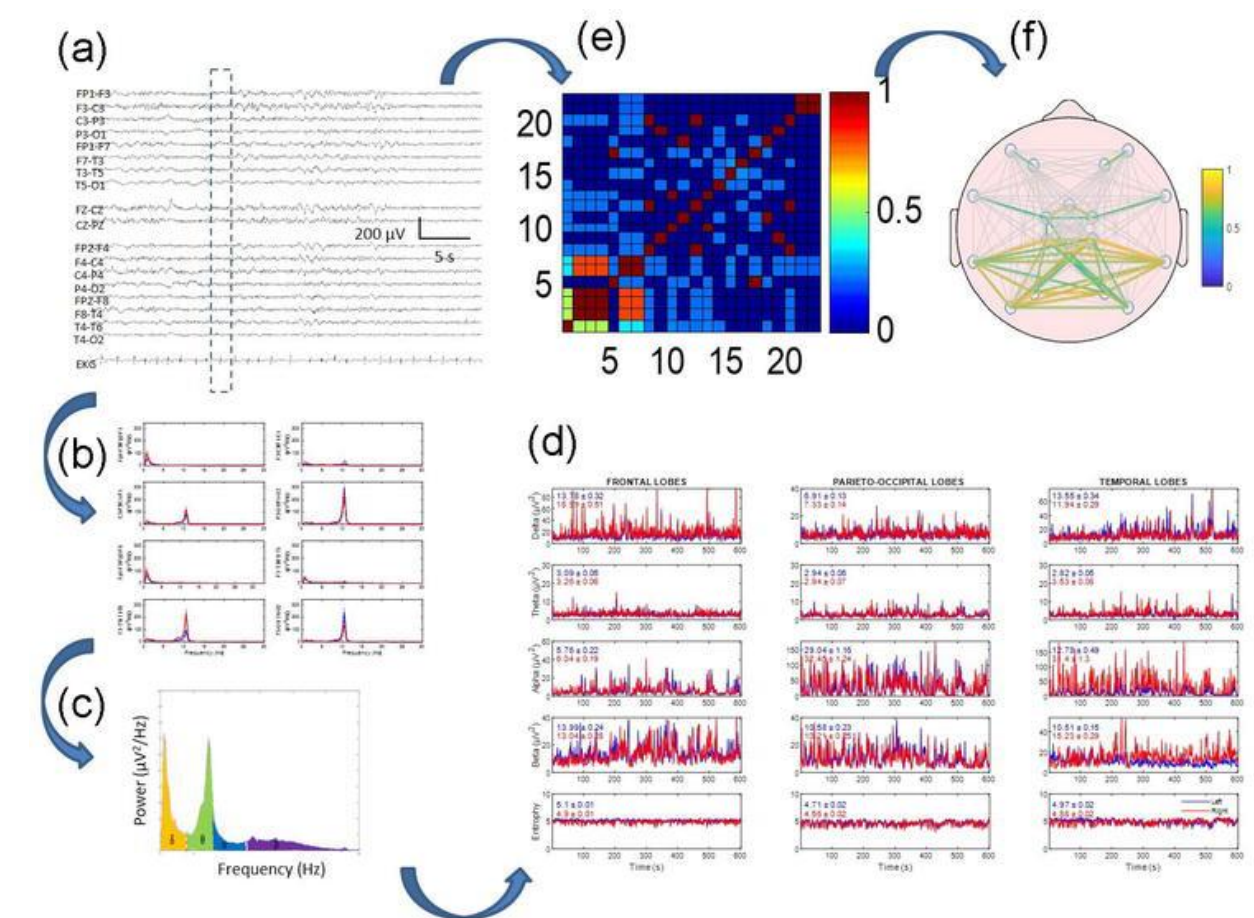
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Quantitative Electroencephalography

Electroencephalography (EEG) is used to assess cortical activity by measuring spontaneous electrical potentials of neurons in the neocortex and allocortex via a set of electrodes at pre-defined positions on the human scalp.

Quantitative EEG (QEEG) is the numerical analysis of EEG signals in both time and frequency domain (see Figure 1) and the associated behavioral correlates.

Figure 1. (a) Raw EEG tracing. (b) Power spectra for each channel. (c) Spectral power in frequency bands. (d) Spectral power and entropy over time for every lobe. Red for right and blue for left hemisphere. (e) Spatial correlation matrix. (f) Mean correlation topography. Modified from [Pastor et al., 2021].



Objective

EEG facilitates assessment of brain function which

- is a non-invasive method,
- is associated with low cost as compared to imaging (MRI, PET, etc.),
- is widely available, and
- has high time resolution.

Observational studies have shown the potential of QEEG measures as diagnostic biomarkers for neurological indications [Ferreri et al., 2022; Aguiar Neto and Rosa, 2019].

There are, however, no universal standards for QEEG application in interventional trials.

This research reviews the current role of QEEG in clinical trials to provide reference for future consolidation efforts.

Methods

A systematic search on ClinicalTrials.gov up to 09-Mar-2023 for "eeg" OR "electroencephalogram" OR "electroencephalography".

Included trials:

Planned, active or completed interventional trials in clinical phases 1-4.

Manual review of trial summaries to assess

- medical condition
- intervention
- EEG purpose
- cognitive state during EEG recording, and
- QEEG endpoints.

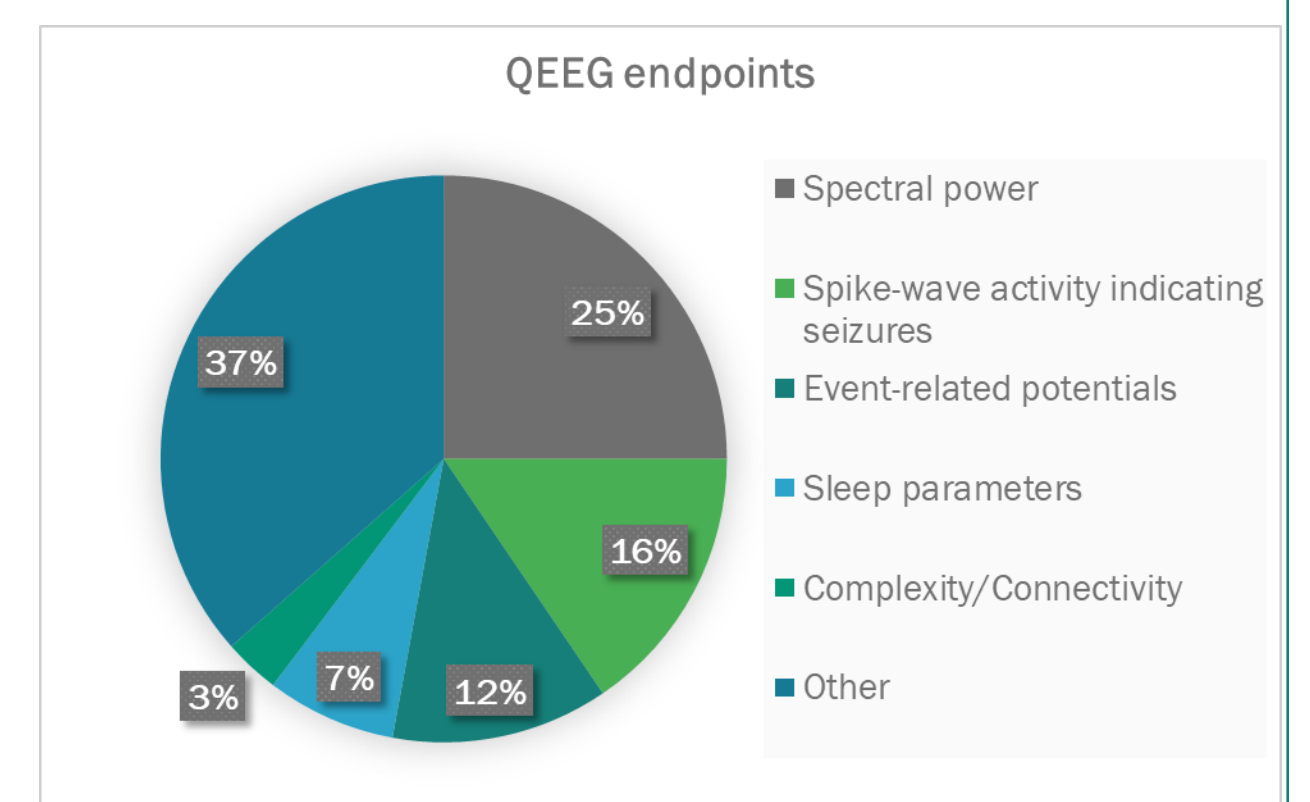
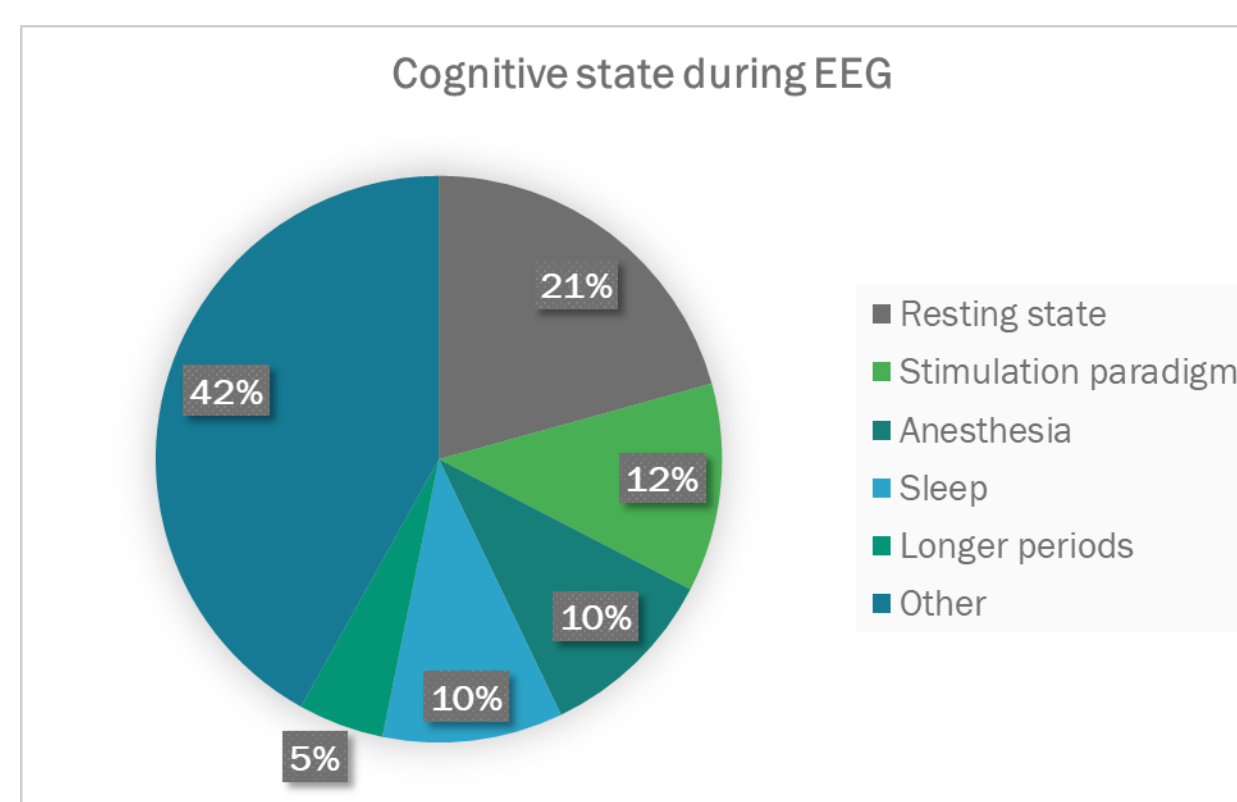
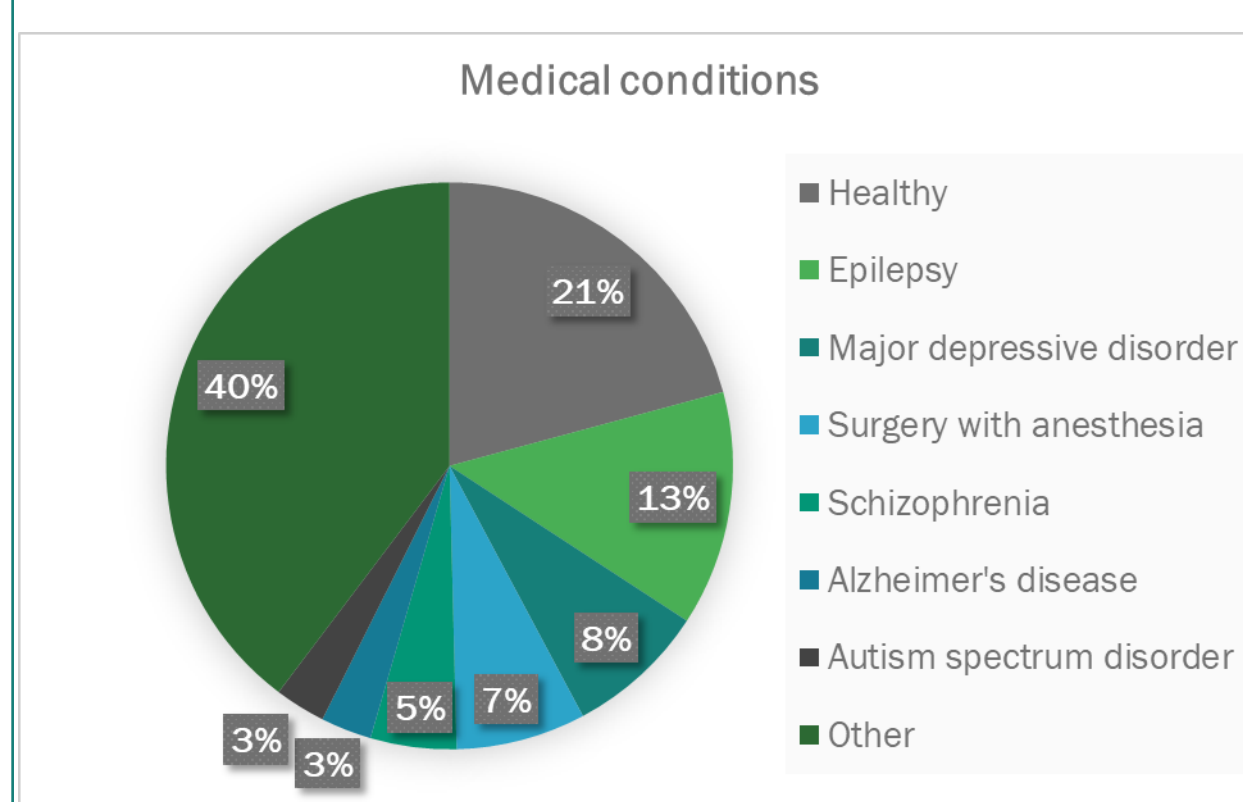
Outcomes described by relative frequencies; no inferential analyses.

Results

The search resulted in a total of 663 included trials.

Intervention: Drug therapy (80.2%); magnetic, electric or light stimulation (10.7%); medical devices (2.7%); neurofeedback training (2.3%).

EEG purpose: Demonstrate efficacy (68.8%); (anesthesia) monitoring (17.2%); as part of the intervention, e.g. brain-computer interface (6.8%).



Conclusion

Review results suggest three major current roles of QEEG in interventional clinical trials:

1. Epileptic seizure detection
2. Anesthesia monitoring during surgery, and
3. Efficacy assessment of interventions for neurological and mental and behavioral disorders

The majority of QEEG analyses is conducted using power spectral analysis.

References

- Pastor J, Vega-Zelaya L, Martín Abad E. Necessity of Quantitative EEG for Daily Clinical Practice. Electroencephalography - From Basic Research to Clinical Applications. IntechOpen; 2021.
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