Towards a Depth of Hypnosis EEG Simulator

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Introduction: Current practice in anesthesia relies on population-based estimates of drug dosage. Considerable inter-patient variability, in particular in children, makes drug delivery guided by a measured physiological end point a desirable goal. As anesthesia primarily affects the central nervous system, EEG [1] is favored as a basis for such Depth of Hypnosis (DoH) measurements. The effects of anesthesia on EEG are poorly understood, and commercial DoH EEG monitors use complex, often undisclosed, methods of analysis. Here we report progress towards an EEG simulator that can be used to further the understanding of a measured anesthesia end point.

Method: We have developed a simulator that uses the audio output of a mobile phone to mimic EEG during anesthesia. A simple two-parameter model, dependent on the known empirical inverse frequency/amplitude dependence of EEG on anesthesia, and the degree of burst suppression, is used to generate an 8Khz audio signal, which is finally fed to the DoH monitor through a passive network representing the electrical impedance of the scalp.

Results: A mobile application for iOS and Android was developed to accept manual entry of a target DoH level, and generate a matching simulated EEG signal on the headphone output, Fig. 1(a). The application has undergone preliminary calibration by manual adjustment and linear interpolation of the model parameters against corresponding readings from a NeuroSENSE (NeuroWave Systems, OH) monitor. An approximate 1:1 relation between the simulator setting and the DoH monitor was obtained, Fig 1(b).

Conclusion: We have developed a first prototype of a DoH EEG simulator using a simple two-parameter model, and shown that it is possible to calibrate the output against a commercial DoH Monitor. Further work is ongoing to improve the performance of the simulator, and integrate the ability to replay previously recorded clinical EEG data, with the ultimate goal of accurately assessing the performance of DoH monitors, and providing a flexible tool for such use.

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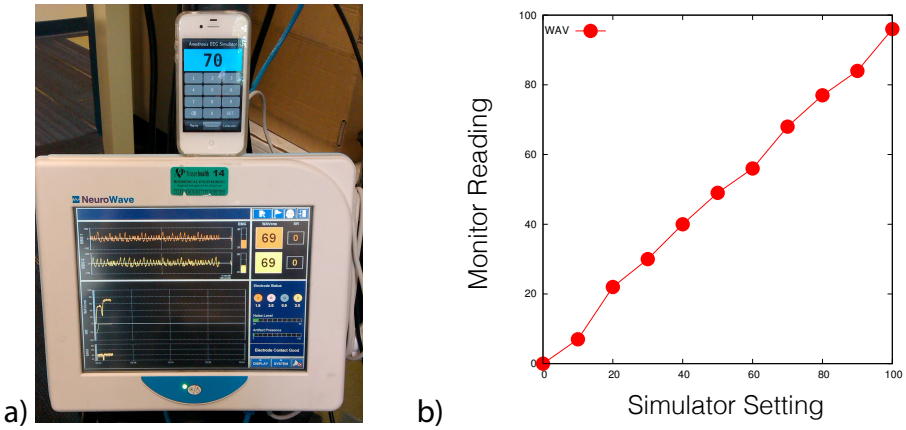

Figure 1: (a) EEG smartphone simulator w. DoH monitor, (b) Preliminary calibration.

[1] Freeman WJ. Origin, structure, and role of background EEG activity. Clinical Neurophysiol. 116 1118 (2005).