Designing Patient-Specific Optimal Neurostimulation Patterns for Seizure Suppression

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Abstract

Neurostimulation is a promising therapy for abating epileptic seizures. However, it is extremely difficult to identify optimal stimulation patterns experimentally. In this study human recordings are used to develop a functional 24 neuron network statistical model of hippocampal connectivity and dynamics. Spontaneous seizure-like activity is induced in-silico in this reconstructed neuronal network. The network is then used as a testbed to design and validate a wide range of neurostimulation patterns. Commonly used periodic trains were not able to permanently abate seizures at any frequency. A simulated annealing global optimization algorithm was then used to identify an optimal stimulation pattern which successfully abated 92% of seizures. Finally, in a fully responsive, or "closed-loop" neurostimulation paradigm, the optimal stimulation successfully prevented the network from entering the seizure state. We propose that the framework presented here for algorithmically identifying patient-specific neurostimulation patterns can greatly increase the efficacy of neurostimulation devices for seizures.

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All the authors have been involved with the work and have approved the manuscript and agree to its submission.

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