**Background**

Nonpharmacologic therapies for epilepsy, specifically epilepsy surgery, focal ablation and implantable devices, are among the most rapidly growing treatments for medically refractory epilepsy, but they are far from optimized. Administration of these therapies, and even the procedures to evaluate patients for them, such as multimodality brain imaging, cognitive testing, and intracranial electrode implantation, are not standardized and nonuniformly employed. Furthermore, standard analyses of these data, especially EEG, rely upon subjective, visual criteria that often do not take advantage of modern technology. There is a clear gap between recent advances in hardware, wearables, and data science that have not been translated into clinical epilepsy care. Fundamentally this is because centers cannot effectively collaborate or pool data for multi-center clinical trials to determine how to enhance clinical care with these new technologies to record, analyze, and treat seizures.

This huge unmet need in epilepsy research has had enormous consequences and touches upon multiple key epilepsy Benchmarks.  It limits our ability to: (1) understand the initiation, propagation, and termination of seizures at the network level in different forms of epilepsy (Benchmark IIIA); (2) to identify quantitative biomarkers for assessing or predicting treatment response, including markers that may identify specific populations that are likely to have good outcomes or develop adverse responses (Benchmark IIIB); (3) to identify, develop, and improve interventions to detect, predict, prevent, or terminate seizures (Benchmark IIID); and (4) to identify, develop, and improve anti-seizure therapies (Benchmark IIIE).  Because of the heterogeneity of approaches to invasive epilepsy therapy, individual centers do not have a large enough volume of patients to address these unmet needs individually, and expertise is often dispersed across institutions.  This requires a large, collaborative infrastructure to improve care and expedite research.

**Major unanswered questions of vital translational significance that could be enabled by such collaborations and tools to guide invasive epilepsy treatments include**:

1. Determining optimal spatial sampling of intracranial EEG and approach (electrode spacing, size, grid, stereo, other)
2. Determining optimal temporal sampling of electrophysiology (sample rate) and at what scale
3. Determining the best multimodal techniques, protocols and resolution to map epileptic lesions, networks and techniques to coregister and display electrode locations..
4. Identify the best biomarkers to localize epileptic networks in a rigorous fashion (e.g. HFOs, seizures, interictal coherence, other methods)
5. Determine the best network methods to enhance visual EEG analysis, characterize epilepsy networks, and localize sites for surgical resection, ablation or device implantation
6. Determine the best invasive treatment for specific epilepsy syndromes in rigorous, multicenter trials

These are only a sampling of the kinds of questions that could be answered by an appropriate collaborative infrastructure to facilitate multi-center collaboration.

**What We Need: An Epilepsy Technology and Analysis Platform**

We propose a community-wide collaboration focused on translating new technologies and techniques into clinical epilepsy care. Funding at this level would establish a rich, translational collaboration that melds quantitative disciplines with state-of-the-art clinical epilepsy data in order to establish the following:

1. A central or federation of cloud-based platforms and tools for standardizing imaging, electrophysiology and clinical metadata for annotation, analysis and sharing. The platform should allow visualization, annotation, analysis, data sharing and publishing via the cloud. It should also handle and analyze multimodal imaging and connect with existing epilepsy imaging consortia.
2. A federated approach whereby data are given standardized labels that identify format, annotations, data quality, and other key information required for analysis. In this way data sets from many different institutions can be merged into multicenter studies without ever having to leave each institution, as analyses are done locally, but according to rigorous standards, protocols and quality metrics.
3. An infrastructure for establishing rigorous standards for electrophysiology and multimodal analysis (e.g. together with imaging).
4. A large cache of multi-scale and high-resolution electrophysiology data from patients implanted with intracranial electrodes who have undergone resective surgery, laser ablation, grid, strip or stereo EEG. These data should include multimodal imaging and implement standardized electrode co-registration and seizure marking, manually and with quantitative tools, and be of high quality. Ideally, eventually, all centers performing intracranial EEG or device implants would share their data through this platform or federation of platforms.
5. A pool of experts to develop and test network models, biomarker detection algorithms, and retrospective quantitative clinical trials of seizure localization and different therapies across a large number of patients, to set up data for prospective trials. Researchers will share data and methods openly with each other in this framework.
6. Establish a large, multicenter "sandbox" of high-quality data upon which to train and test new analytic tools, which will greatly accelerate and economize future quantitative epilepsy research. This “sandbox” can also serve as the best place to train new investigators interested in quantitative research and engineering solutions applied to epilepsy care.

We point to the successes of IEEG.org with establishing now gold standard algorithms for seizure detection and prediction that are used worldwide, as well as an infrastructure on which to benchmark and publish new algorithms that may have promise to improve upon these standards.  We believe this same infrastructure or type of infrastructure could dramatically improve invasive epilepsy treatment, research and training. It will also accelerate basic and translational epilepsy research and clinical trials at numerous levels, including in biomarkers, antiepileptic medications and comorbidities.

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