SEIZURE PREDICTION – IS THE FUTURE MULTIMODAL?

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Epilepsy – one of the most common serious neurological disorders – affects approximately 65 million people worldwide. About 20-30% of patients remain poorly treated or untreated, despite modern drug therapies and advanced surgical methods. These patients require comprehensive care to address the adverse events of medical treatment, quality of life issues, and comorbid disorders. Research over the last two decades suggests prevention techniques based on the prediction of seizures as an alternative treatment for previously uncontrollable seizures. Such an approach has a high potential for preventing injuries, and allowing subjects with multifocal or poorly localized seizures to re-enter society.

Despite the immediate availability of a number of highly sophisticated analysis techniques used for seizure prediction, together with publicly available high-quality, multi-channel, multiday, electroencephalographic recordings (EEG), there are still many overoptimistic claims about predictability of seizures. Research into this field recently has seen a surge of blind applications (facilitated through competitions) of a large number of analysis techniques (try sufficiently many and one will be significant); an approach challenging statistics, data acquisition, and experimental designs. Many studies have been performed with no or only little consideration of underlying seizure-generating mechanisms and have used only the EEG, a modality which may not lend itself to fully determine underlying mechanisms.

The brain is an extremely complex, highly nonlinear, adaptive, open system, from which complicated physiologic and/or pathophysiologic dynamics emerge. Addressing the challenge of reliably predicting seizures based on first principle modelling is not sensible and not feasible. Serious future success will eventually require a broadening of our view on the complex dynamical disease epilepsy through merging multimodal, real-time information from various physiologic systems, and including behavioural data. This requires new recording and analysis frameworks together with new mathematical and statistical approaches to bridge the various spatial and temporal scales involved in the epileptic process.

The timing is right to introduce a multimodal system as biosensor technology (wearables) is advancing fast and reaching consumers, whilst cloud computing can now provide the enabling of low-cost platforms for complex analysis on the move.