SEIZURE FORECASTING USING MACHINE LEARNING MODELS TRAINED BY SEIZURE DIARIES

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Approximately 1% of the global population has epilepsy, and 30-40% of those affected continue to experience seizures despite using anti-seizure medications. One of the most challenging aspects of seizures is their unpredictability, which leads to a phenomenon called "seizure worry," or simply put, the fear of when the next seizure will occur. Finding a way to better predict the timing of the next seizure would provide patients with greater control over their lives.

Recent studies have confirmed that seizures in some patients tend to occur in cyclic patterns. If these patterns can be recognized using machine learning, it can become possible to more accurately predict the timing of the next seizure. In the study by Gleichgerrcht et al., to determine if that is even feasible, machine learning was applied to seizure diary logs collected as part of the Human Epilepsy Project. From this project, self-reported seizure logs of 153 participants were used and each of them had at least three documented seizures. The data was gathered from patients diagnosed with focal epilepsy. A leave-one-person-out cross-validation scheme was used, in which the seizure diaries of all but one patient were used for training the algorithms and then applied to the left out subject for validation. Both statistical (Bayesian fusion) and ML-based regression forecasting models (SVM, LSTM) were used. The results show that 75% of seizures were predicted within ±1 day of the actual seizure, and 85% within an average of ±3 days. Seizure predictability varies between individuals, patients with more frequent seizures generally showed better predictability. The results of this study indicate that every individual shows a different level of seizure predictability and that the forecasts were more accurate when using longer seizure histories. The real importance of these results is that they support the theory that an undetermined "pacemaker" dictates the timing of an epileptic seizure. Confirming that theory may help with identifying it in the future. This study focused only on the interval between seizures, excluding the time of day, day of week and season, which could potentially reveal new patterns that were not recognized before. Another limitation is that the study excludes a number of factors that can contribute to seizures happening, such as periodical behavior (drinking alcohol on weekends) and geography (different temperatures, atmospheric pressure and conditions). It is important to consider that patients' seizure diaries in clinical practice may not be as well-maintained as those of participants in the trial. Furthermore, there is no evidence that the participants were consistent in logging their seizures and it is likely that they have documented only their most significant seizures. To achieve the best results, combining diary-based methods with EEG data could be beneficial.

In conclusion, seizure forecasting with machine learning models could, when perfected, help patients reduce their seizure worry and help them lead more normal lives. In addition, an advantage of this method is that it is cost-effective and non-invasive, as opposed to similar methods that rely on classic or intracranial EEG.

REFERENCES:

1. Gleichgerrcht E, Dumitru M, Hartmann DA, et al. Seizure forecasting using machine learning models trained by seizure diaries. *Physiol. Meas*. 2022;43(12):124003-124003. doi:https://doi.org/10.1088/1361-6579/aca6ca