

# A Short Note on Diagnosis and Study of Epilepsy

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## Abstract

One of the main tools for diagnosing and studying epilepsy is electroencephalography (EEG), which can be used right after a possible first seizure. The most settled biomarker of epilepsy, in the event that seizures are not recorded, are interictal epileptiform releases (IEDs). However, in clinical practice, IEDs are not always present, and the EEG may appear normal despite an underlying epileptic disorder, making the diagnosis of the disease frequently challenging. As a result, it would be extremely beneficial to discover additional biomarkers that can accurately predict whether a person has epilepsy even in the absence of obvious epileptic activity. These biomarkers have the potential to shorten the period of diagnostic uncertainty and, as a result, reduce the risk of seizures. EEG features other than IEDs appear to be the only ones capable of distinguishing between epilepsy, which has a risk of > 60% of recurrent seizures, and other (pathological) conditions at this time. The purpose of this narrative review is to provide an overview of the methods used to identify the EEG-based biomarker candidates for epilepsy.

**Keywords:** Alzheimer's disease; Epilepsy; Biomarker; Diagnostic; Electroencephalography

## Introduction

Seizures, either focal (partial) or generalized, are frequently seen in epilepsy. Generalized seizures occur when abnormal activity affects both hemispheres, including their cortical and subcortical structures, whereas focal seizures occur in one or more circumscribed regions of the brain. According to Sander, Ngugi et al., this disorder affects 0.5%–1% of the population. (2011), and thirty to forty percent of it developed pharmacoresistant status. According to Angus-Leppan, one of the main characteristics of epilepsy is the presence of seizures, but this does not guarantee that the patient will eventually develop the disease [1]. Truth be told, around 10 % of people might have a solitary seizure in the course of their life as a side effect of an intense affront of the focal sensory system, for example serious hyponatremia. As a result, it is frequently challenging for medical professionals to provide a correct diagnosis right away following a first seizure, with an overall misdiagnosis rate of up to 23%. In the event that the patient does not actually have epilepsy [2], this, on the one hand, results in unnecessary medical treatment with undesirable side effects. However, withholding treatment when it is necessary and leaving patients untreated may be even more critical because it increases the likelihood of additional seizures, trauma, and, in some instances, death [3].

A tool that helps doctors identify and differentiate characteristics of brain activity only related to epilepsy would be extremely helpful, given the difficulty of diagnosing a first seizure. When a patient arrives at the hospital complaining of a suspected first seizure, being able to identify specific features of the EEG signal that reliably permit detecting epilepsy could lead to fundamental improvements in assisting and treating them. In addition, doctors may be able to estimate the success of the prescribed treatment using quick screening tools that provide both qualitative and quantitative measurements [4]. Ideally, this instrument should be able to: recognize dependably between a first epileptic occasion with regards to a beginning stage epilepsy jumble and a non-epileptic occasion, or an intense indicative seizure because of a transient fundamental affront, recognize, in the event of an affirmed epileptic problem, the sort of epilepsy (for example summed up or central), as forecast and treatment vary between epileptic turmoil classes, be effectively usable in a completely programmed way, consequently lifting the responsibility from clinical specialists who might then get solid outcomes basically by taking care of the EEG signal into a committed programming [5].

## Method

Late examinations have shown the likelihood to evaluate the presence of epilepsy by taking a gander at various measures, making scientists think these could be solid biomarkers permitting its recognition and finding. The range of these biomarker possibilities includes gene expression, biomarkers of metabolism, structure modifications of the human brain [6].

In the field of epilepsy research, electroencephalography is the most readily available and well-established method. As a result, the established or potential electrophysiological signal changes that could be reliable EEG biomarkers of epilepsy will be discussed in this review, as will the clinical application of EEG in this setting. These progressions can be connected with explicit parts of the infection, contingent upon whether there is a high gamble of seizures to happen (interictal state) or seizures are happening (ictal state) [7]. In clinical practice, the doctor almost always has to deal with an EEG that was taken while the patient was in the interictal state. The EEG tracing doesn't always show specific signs that the disease is happening. As a result, it becomes abundantly clear that finding epilepsy even when there are no seizures is of the utmost importance. However, according to Engel (2013), no EEG biomarker has yet been found to be highly reliable for detecting and predicting epilepsy, particularly during the interictal phase. The most recent techniques for extracting potential EEG biomarkers from the EEG signal will be discussed in the following sections [8].

## Result

According to Strimbu and Tavel (2010) and Califf (2018), a diagnostic biomarker ought to be able to accurately and reproducibly identify the presence of a particular disease and differentiate between

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its subtypes. According to Richardson (2012), Kramer and Cash (2012), epilepsy is both a structural and a functional network disorder that affects brain regions that are connected locally and remotely [9]. As a result, previous research has focused on abnormalities in the brain's structure and functional network properties when looking for biomarkers. Even though there may be differences in the structure of the brain between epileptic patients and healthy controls, it is harder to find these differences when brain activity is looked at. In this article, we go over a variety of electrophysiological biomarkers that can be used to identify epilepsy before the symptoms appear [10].

## Discussion

It is assumed that IEDs are present in the EEG tracing but cannot be identified by the epileptologist who is performing the visual reading in patients who have a clear epilepsy diagnosis but a negative routine EEG. These IEDs are referred to as "hidden" IEDs. This condition can be caused by a number of things: a) the IED is too small and is therefore overlooked; b) it originates in deep brain regions that are difficult to detect using scalp electrodes (such as the insula); or c) it is barely covered by scalp electrodes (such as the basal temporal regions). Different approaches can be taken based on which of these scenarios is the most likely explanation. If the patient presented with a right eye and head deviation, for example, zooming in on the electrodes that most likely cover the possible focus (such as left hemispheric contacts) may increase the likelihood of identifying the IED in the first case [11]. In the second and third situations, increasing the number of electrodes that is, using 40–64 electrodes or more could improve the coverage of the scalp and increase the likelihood of observing the IED.

## Conclusion

The possibility of locating "hidden" IEDs in the EEG signal in the time, frequency, and time–frequency domains was looked into in a number of studies. In terms of relative amplitudes, slope, and curvature, these techniques have been investigated further. Chavakula and others utilized a wavelet change based calculation straightforwardly applied to the crude EEG information and looked at precision in five distinct circumstances: (1) by considering only one channel, or 2) multiple channels across various sleep-wake cycles; 3) testing the accuracy of identifying IEDs in the left and right hemispheres; 4) utilizing machine learning (ML) to enhance detection performance; and 5) either only during wakefulness or across all sleep-wake cycles. Both during wakefulness and sleep, the authors demonstrated that their algorithm was able to rapidly and precisely quantify and localize interictal spikes

directly from the unprocessed EEG signal (sensitivity > 70%, specificity > 80%) and was largely insensitive to artifacts. Thomas and co used an EEG classification system with three modules pre-processing, waveform classification, and EEG classification) to analyze 30-minute EEG recordings from 156 epileptic patients (93 with marked IEDs and 63 without IEDs). To eliminate baseline fluctuations, the authors down sampled the data to 128 Hz, applied a 60-Hz notch filter, and used a 1-Hz high-pass filter. They then, at that point, grouped explicit waveforms into either IEDs or foundation movement. A machine learning (ML) algorithm was used to further analyze the classification output, resulting in an 84% accuracy rate for IED detection.

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