Artificial Intelligence Models for Diagnosing Epilepsy by Seizure Monitoring: A Systematic Review

Amir Ehsan Heydari[1], Mohammad Reza Mazaheri Habibi[2*], Azam Kheirdoust[2], Fateme Karimi Moghaddam[2], Sana Mahmoudi[2], Sadaf Afkhami Pirabarji[2], Sajed Arabian[3]

[1]School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
[2]Department of Health Information Technology, Varastegan Institute for Medical Sciences, Mashhad, Iran
[3]School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran

*Corresponding Author:
Dept. of Health Information Technology, Varastegan Institute for Medical Sciences, Mashhad, Iran

ABSTRACT

Introduction: Epilepsy is the third neurological disorder after stroke and migraine. Seizure is one of the important clinical manifestations for its diagnosis and affects the physical and mental health of sufferers. Examining the electroencephalogram (EEG) by the medical staff is a strategy to diagnose seizures, but it is a laborious and error-prone process. Therefore, several methods of automatic seizure detection based on machine learning have been applied in recent years. However, their clinical application has hindered its progress due to the need for high-quality data and advanced computing resources during implementation. This study aimed to evaluate artificial intelligence (AI) models for epilepsy diagnosis based on seizure monitoring.

Methods and Materials: This systematic review study was conducted in 2024 by searching the reliable databases of PubMed, Scopus, Web of Science, and Google Scholar search engine. Keywords "epilepsy", "seizures", "monitoring", "electro-encephalography", "artificial intelligence", "machine learning", and "deep learning" were investigated in related studies between 2020 and 2024. English-language studies investigating AI models for epilepsy diagnosis based on seizure monitoring met the inclusion criteria. In addition, review articles and studies that did not focus on patients with epilepsy were excluded from the study. Titles and abstracts were evaluated independently by two evaluators. Then, the full text of the articles was checked, and an identical form with the fields of study title, year of publication, country, number of data, type of algorithm, study objectives, and main findings of the study was used for the data extraction stage.

Results: A total of 1,267 articles were retrieved from the mentioned databases. After reading the titles and abstracts of articles and considering the inclusion and exclusion criteria, 144 articles were included in the study. Among studies, 41 (28.5%) investigated standard data mining methods such as decision trees, clustering, classification, and neural networks, which were valuable and effective in seizure diagnosis and prediction. Also, 52 (36.1%) studies evaluated a deep learning or convolutional model that increased accuracy and sensitivity. Furthermore, 51 (35.4%) studies compared various types of multi-layered and deep AI methods, as well as their combinations. In most cases, these approaches not only improved accuracy and specificity but also reduced processing time, thereby enhancing the feasibility of using this technology in clinical settings.

Conclusion and Discussion: The findings of this study demonstrate that AI models are adequate for diagnosing epilepsy from EEG data and predicting seizures. Correct and timely prediction of seizures with the help of AI improves the quality of life and better management of this disease in affected people, and its use will be a promising strategy in the self-management of these patients.

Keywords: Artificial intelligence, Electroencephalography, Epilepsy, Seizures