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Clinical Approach to Differentiating Epileptic Seizures from Bipolar Disorder

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Abstract

Distinguishing between epileptic seizures and bipolar disorder in clinical setting presents a significant challenge due to overlapping symptoms and the complex mechanism underlying both conditions. This study offers a novel perspective by integrating the latest research and clinical practices to explore this intricate diagnostic landscape. Unlike previous studies that primarily focused on isolated aspects, this study synthesizes recent advancements in neuroimaging, wearable technology, and machine learning to enhance diagnostic accuracy. Data sources searched were Google Scholar, PubMed, and ScienceDirect using the keywords of 'epileptic seizures', 'bipolar disorder', 'diagnosis', 'neuroimaging', 'wearable technology', and 'machine learning'. Following the Preferred Reporting Item for Systematic Review and Meta-Analysis (PRISMA) methodology, the findings highlight how the variability of mood episodes and their resemblance to seizure activity often complicate differential diagnosis. Moreover, they underscore the potentials of emerging technologies, such as real-time monitoring via wearable devices and AI-driven diagnostic tools, in refining current clinical approaches. This study emphasizes the necessity of clinic awareness regarding subtle but crucial distinctions between bipolar disorder and epileptic seizures. By leveraging continuous monitoring and data-driven insights, an innovative framework that combines clinical expertise with advanced technology is proposed, paving the way for more precise and effective diagnostic methods.

Keywords: Bipolar disorder, differential diagnosis, diagnosis, epileptic seizures

Introduction

Epileptic seizures are temporary neurological events caused by excessive or unusually synchronous neuronal activity in the brain. Their clinical manifestations vary based on factors such as the site of onset, brain maturity, and confounding conditions.[1] Seizures are unpredictable, potentially life-threatening, and classified into focal onset, generalized onset, or unknown onset.[2] Despite advances in epilepsy research, determining its etiology remains challenging due to heterogeneity, requiring sophisticated diagnostic tools.

Bipolar disorder is a chronic psychiatric condition comprising bipolar I disorder (BD I) and bipolar II disorder (BD II). BD I presents with manic episodes, while BD II includes hypomanic and major depressive episodes.[3] Diagnosing bipolar disorder is complex due to symptom overlap with other psychiatric conditions, frequent comorbidities, and the absence of objective biomarkers. This overlap creates a significant challenge in distinguishing between epileptic seizures and bipolar disorder, as both conditions share clinical similarities, including transient mood and behavioral changes.[4]

The difficulty in differentiating epileptic seizures from bipolar disorder has significant clinical consequences. Epileptic seizures can be diagnosed using clinical manifestations, EEG, ECG, neuroimaging, and laboratory findings. However, due to variations in symptoms, distinguishing epileptic from non-epileptic seizures remains difficult. Similarly, bipolar disorder diagnosis is hindered by symptom overlap, lack of patient awareness, and societal stigma.[4] Misdiagnosis can lead to inappropriate treatment strategies, exposing patients to ineffective or even harmful interventions, thereby worsening their prognosis.[5] Given the potential for severe morbidity and mortality

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associated with both conditions, improving diagnostic accuracy is crucial.

Advancements in neuroimaging techniques have enhanced the diagnosis of both epileptic seizures and bipolar disorder by identifying structural abnormalities.[5] Recent research has also explored the role of wearable devices and machine learning in refining diagnostic precision.[4] These technologies offer promising solutions by providing objective and quantifiable diagnostic markers. However, previous studies have mainly focused on comparing epilepsy with non-epileptic seizures or bipolar disorder with other psychiatric illnesses, often without an integrated interdisciplinary approach.[3,6,7]

This study provides a novel interdisciplinary approach by integrating genetic biomarkers, neuroimaging techniques, and immune factor analysis to improve diagnostic accuracy between epileptic seizures and bipolar disorder. Unlike previous studies that focused on isolated diagnostic tools, this research examines the combined potential of genetic markers (SCN1A for epilepsy and CACNA1C for bipolar disorder),[8,9] immune response biomarkers (IL-6 and TNF-α),[1,10] and neurophysiological assessments (vEEG, MRI, and machine learning-based tools)[5,6,11] to establish a comprehensive and evidence-based diagnostic framework. The findings of this study will bridge the gap between neurology and psychiatry, offering a more integrated diagnostic pathway for clinicians.

To address these diagnostic challenges, this study proposes an interdisciplinary approach combining expert opinions from neurology and psychiatry alongside an extensive survey of current diagnostic methodologies and technological advancements. The integration of neuroimaging innovations, molecular genetics, and expert consensus provides a robust diagnostic framework that enhances accuracy. Additionally, the study evaluates the utility of emerging technologies such as machine learning-based assessment tools to improve real-time diagnostic precision.[9]

This study aims to establish an evidence-based diagnostic framework that improves the differentiation of epileptic seizures from bipolar disorder. By investigating advanced neuroimaging methods, molecular biomarkers, and interdisciplinary diagnostic techniques, this research seeks to refine clinical decision-making and optimize patient care. The findings will contribute to developing a standardized diagnostic approach that minimizes misdiagnosis and enhances patient outcomes, particularly in clinical settings where diagnostic ambiguity remains a challenge.

Methods

This study uses a narrative review approach based on research articles available on Google Scholar, PubMed, and Science Direct with the keywords "epileptic seizures" and "bipolar disorder" combined with "detection", "diagnostics", "wearable devices", and the "machine" is learning". The method for conducting this review is to follow the Preferred Reporting Item for Systematic Review and Meta-Analysis (PRISMA) method.[26] The literature review is carried out in four stages, namely; selection criteria, information sources, filtering, and Data analysis. The selection criteria in this review are published in English, published during 2014–2024, full text articles are available, topics discussed are epilepsy or bipolar disorder. Exclusion criteria are only abstract articles, and Science Direct.

Results

Article filtering was carried out using a combination of keywords as stated in the method section. Initial identification found 1601 articles. After screening, including the inclusion criteria, 75 articles were obtained. 31 of 75 articles were excluded due to ineligible methodology and 44 articles were further screened. There were 10 articles eligible for review and based on their relevance, 7 articles were included for review. The detailed screening process can be seen in Figure 1.

This summary covers seven studies on epilepsy, seizure detection, and psychiatric disorders. Research highlights challenges in epilepsy diagnosis, with machine learning and deep learning improving seizure detection and prediction. Genetic markers aid epilepsy classification, while ML enhances psychiatric disorders diagnosis. Neuroimaging studies identify cerebellar and frontoparietal biomarkers for bipolar disorder, supporting early diagnosis and treatment. Table 1 provides detailed findings.

Article 1 states that in determining the diagnosis and prognosis of epilepsy, immune factors in the blood can be considered as biomarkers of epileptic seizures. According to article 2, the symptoms of epileptic attacks originate from abnormal brain function.

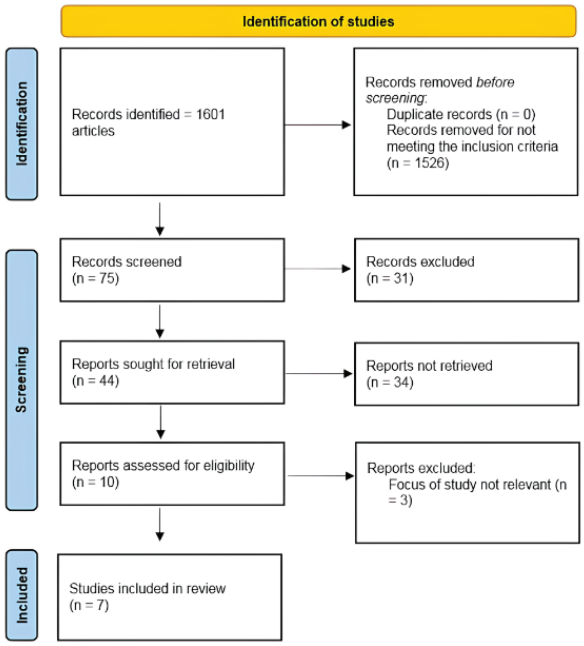

Figure 1 Article Screening Process

Furthermore, article 3 states that genetic biomarkers are considered as one of the etiological factors of epileptic seizures. In identifying new genes associated with epilepsy, genetic testing can be used because differences in genetic results cause different types of epilepsy.[8] In article 4 it is stated that seizure activity depends on the localization of the epileptogenic zone in the brain.

Articles 5 and 6 state that genetic expression in the brain, particularly the cerebellum, is found to be a biomarker for bipolar disorder and other neuropsychiatric diseases. Identification of biomarkers can be used for classification and provide insight into the biology underlying behavioral symptoms in psychiatric disorders.[9,15] Article 7 states that changes in function and morphology in several local parts of the brain are found in patients with bipolar disorder.[10] Biomarker detection can be useful for early treatment of patients.

In article 1 it is stated that a video-electroencephalogram or vEEG is needed to verify the interictal, ictal and postictal periods in the evaluation of seizures. Neuroimaging via vEEG can verify immune factors in temporal lobe seizures in adults. Article 2 finds that an electroencephalogram or EEG is used to determine electrical recordings of brain activity which are then used to categorize epilepsy patients.[8] Neuroimaging such as EEG is necessary in delineating the epileptogenic zone of epilepsy. EEG combined with other neuroimaging tools can increase accuracy in localizing the epileptogenic zone. Article 4 found that Electrical Impedance Tomography (EIT) has the potential to improve localization of the epileptogenic zone. In bipolar disorder, article 7 states that neuroimaging techniques such as MRI are used to identify functional brain abnormalities and classify the type of bipolar disorder. With neuroimaging, pathological mechanisms that trigger manic episodes can be identified.[7]

Advances in medical equipment and neuroimaging are being made to improve the diagnostics and detection of diseases and disorders, including epileptic seizures and bipolar disorder. The detection model was proven to be 99% more accurate in evaluating epileptic seizures, reducing the False Alarm Rate (FAR) in a shorter time. Article 2 finds that by using machine learning algorithms, classification and prediction accuracy can be improved. Meanwhile, article 3 found that advances in genetic testing also helped reclassify epilepsy with clinical correlation and segregation studies. For bipolar disorder, article 5 finds that machine learning is also used in optimizing genetic analysis for diagnostics and classification. Machine Learning tools can minimize human error and increase

Table 1 Summary of 7 Articles

Article	Author	Subject	Method	Result	Key Finding
1	Elger CE, Hoppe C. (2018)[1]	Epilepsy-diagnostic challenges	Clinical evaluation, EEG, patient self-reporting	Challenges in accurate seizure reporting and diagnosis	Under-reporting and misdiagnosis are common in epilepsy
2	Thangarajoo RG et al. (2021)[13]	Machine learning for epileptic seizure detection	Wavelet and EMD-Based Decomposition Techniques	Improved epileptic seizure detection using ML techniques	ML-based methods improve seizure detection significantly
3	Akbar F et al. (2022)[8]	Genetic testing in pediatric epilepsy	Genetic testing for epilepsy classification	Genetic markers identified for epilepsy classification	Genetic markers can refine epilepsy classification
4	Jaishankar B et al. (2023)[14]	Deep learning for seizure prediction	Deep learning model for seizure prediction	Deep learning model enhanced seizure prediction accuracy	AI models increase accuracy of seizure onset prediction
5	Yang Q et al. (2022)[9]	Machine learning for psychiatric disorder classification	Machine learning-based classification	Machine learning improved psychiatric disorder classification	Machine learning enhances psychiatric diagnosis accuracy
6	Thomaidis GV et al. (2023)[15]	Cerebellar biosignature in bipolar disorder	Automatic machine learning analysis	Identified unique cerebellar patterns in bipolar disorder	Cerebellar abnormalities serve as bipolar biomarkers
7	Gao Y et al. (2023)[10]	Neuroimaging biomarker for bipolar disorder	MRI-based frontoparietal network analysis	Frontoparietal network homogeneity as a bipolar biomarker	Neuroimaging biomarkers aid in bipolar disorder treatment

classification accuracy. According to article 6, this is very useful in the diagnosis of psychiatric disorders.[16]

Discussion

Epileptic seizures are temporary occurrences of signs and/or indications due to strange or synchronous nerve movements in the brain. The hallmarks of seizures are chaos, muscle twitching, and twitching, all caused by a multitude of electrical actions within the brain's neurons. These seizures disrupt normal brain function, varying in strength and duration, ranging from momentary loss of consciousness to prolonged attacks.

The mental illness known as manic depression, or bipolar disorder, causes severe and unpredictable mood swings. Bipolar disorder is an episodic up-and-down flow of mood swings. Affected individuals experience increased mood, energy, and impulsivity during manic or hypomanic episodes. After a manic episode, the person usually experiences a major depressive episode, which makes them feel sad, hopeless, and disinterested in activities. The severity and duration of mood episodes are used to categorize the condition into different types. Severe manic episodes define bipolar I disorder and are often followed by depressive episodes, whereas hypomanic episodes and major depressive episodes are characteristic of bipolar II conditions. Cyclothymic disorder is a milder form, featuring several periods of hypomanic symptoms and depressive symptoms that do not meet the criteria for a severe episode.

Previous research suggests that epilepsy and bipolar disorder can coexist in individuals. Within ten years or more post-hospital admission, the ratio of epilepsy following bipolar disorder is higher compared with shorter time spans. The

cause was likely due to epileptic seizures which were initially diagnosed as bipolar disorder which were later reclassified. Conditions coded as bipolar disorder can include interictal dysphoric and other cases of bipolar disorder. 3Treatment of bipolar disorder may benefit from epilepsy medications such as brain stimulation and epilepsy treatment using anticonvulsants.

The episodic nature of these two diseases is one notable similarity. Experiences of mania, hypomania, and depression occur regularly in people with bipolar disorder, while seizures or seizure episodes sporadically affect people with epilepsy. Disorders such as bipolar and epilepsy are difficult to diagnose because the patterns of seizures and mood attacks are almost indistinguishable. Adding to this puzzle is the fact that the glutamate, GABA, and dopamine systems that influence brain neurotransmitter activity are common to both conditions. When this pathway is damaged, the disorder can worsen and increase. Additionally, the data suggests a possible genetic vulnerability shared by bipolar disorder and epilepsy. Susceptibility to both disorders has been associated with certain hereditary variables and differences in genes relevant to neuronal excitability and synaptic function. This genetic overlap highlights the complex interplay between genetic factors and environmental influences in the manifestation of these disorders.

Apart from being episodic, epilepsy and bipolar disorder also have the same probability in the kindling model and the use of antiepileptic drugs (AED) for the management of both. In the kindling model, repetitive electrical stimulation causes profound changes and may prolong episodes of epilepsy and bipolar disorder.[17] A future-oriented learner-centered 'Empowerment Paradigm' that empowers and endorses all learners with future success. It is an influential and tempting way of restructuring and reorganizing engineering education. Washington Accord, an International accreditation convention, an independent agreement between signatory organizations to provide an external accreditation to undergraduate engineering programs. The accredited engineering programs that qualify an engineer to enter into the practice of professional engineers are equally recognized and acknowledged by other signatory countries and responsible organizations Pakistan Engineering Council (PEC The ignition mechanism may explain the common underlying pathophysiology between epilepsy and bipolar disorder. Several neurotransmitters such as GABA, excitatory amino acids (EAA), dopamine, and serotonin imbalance are known to impact epilepsy and bipolar disorder. It is important to know whether mood stabilizers, especially AEDs, can provide neuroprotective effects. This is because excessive neurotoxicity may be associated with epilepsy and bipolar disorder.

In the treatment of epilepsy, vagus nerve stimulation (VNS) is an option for pharmacoresistant epilepsy patients aged four years and over who cannot undergo or fail to undergo resective surgery. Approximately 8% of patients achieved seizure freedom after >2 years of VNS treatment and approximately 50% experienced a reduction in seizure frequency of at least 50%. Despite the low rate of seizure freedom, epilepsy patients are still advised to undergo neuromodulation treatments such as VNS. Interest is increasing in brain stimulation as an adjunct or alternative to medication and psychotherapy for bipolar disorder, and the evidence base is growing rapidly. Treatment options such as deep brain stimulation or vagus nerve stimulation may address some of the challenges associated with the complex clinical picture of bipolar disorder in difficult-to-treat patients. Additionally, Vagus nerve stimulation (VNS) has been proposed to improve attention and working memory. Vagus nerve stimulation (VNS) is intended to treat major depression or resistant bipolar disorder when the patient is refractory to conventional treatment or is indifferent to medications or convulsive seizure therapy. However, it was found that VNS took longer to improve the condition.

Over the past two decades, the use of anticonvulsants for the treatment of bipolar disorder has increased rapidly in accordance with recent findings of the efficacy of valproate, carbamazepine, and lamotrigine. Previous research found that carbamazepine and valproate proved effective as mood stabilizers in bipolar disorder patients. Lamotrigine is also known to have a much better effect in treating depressive episodes in bipolar disorder compared to placebo. Valproate has been found to be a safe option with favorable side effects in association with short-term mania or mixed states. Meanwhile, carbamazepine has the best efficacy in treating mania and lamotrigine has the mildest side effects and is mainly used to prevent depression recurrence. These similarities may stem from similar pathophysiology. Therefore, epileptic seizures and bipolar disorder may benefit from the use of neuroimaging and machine learning.[7]

Pathobiological differences between epileptic seizures and bipolar disorder can be seen through neurotransmitter imbalances, ion channel dysfunction, neural networks, irregularities, genetic factors, and neuroinflammation and neuroprotection. Considering the imbalance of neurotransmitters, in epileptic seizures, abnormalities in excitability and neural synchronization arise from an imbalance of neurotransmitters, namely glutamate and gamma-aminobutyricacid (GABA), which triggers epileptic attacks. Meanwhile, in bipolar disorder, changes in mood and changes in energy levels are symptoms of bipolar disorder which are caused by an imbalance in the neurotransmitter system of serotonin, dopamine and norepinephrine. From ion channel dysfunction, epileptic seizures can be triggered by abnormal discharges and brain hyperexcitability that may be caused by mutations in ion channel genes, particularly those related to voltage-gated sodium channels. Meanwhile, in bipolar disorder, involvement of ion channels, particularly calcium channels, has been linked to the pathophysiology of bipolar disorder, potentially affecting mood regulation and neural communication. However, ion channel damage is not the main cause.[9]

For neural network disorders, epileptic seizures caused by abnormal synchronized neural activation patterns in certain brain regions or tissues can disrupt the balance between excitatory and inhibitory neurons and cause epilepsy. Meanwhile, a common characteristic of bipolar disorder is disruption of the prefrontal cortex and limbic system, the two main brain networks that regulate emotions. Genetic factors also play an important role in epileptic seizures and bipolar disorder. Several genetic disorders that impact ion channels, neurotransmitter receptors, or synaptic proteins can make a person more susceptible to epilepsy. Bipolar disorder is known to have a complex genetic basis consisting of many susceptible genes, each with minimal impact, and has been implicated in genes related to synaptic plasticity, neurotransmitter pathways, and circadian rhythms.

The final pathobiological difference between bipolar disorder and epileptic seizures can be seen from their neuroinflammation and neuroprotection. Neuroinflammation and disruption of the neuroprotective system may be involved in the development of epileptogenesis, which can lead to recurrent seizures and nerve damage. Investigations into the exact relationship are still ongoing, but low-grade chronic neuroinflammation has been observed in bipolar disorder, which may be related to oxidative stress and altered neuroprotective mechanisms.

According to Goodwin and Jamison, the differences between epileptic seizures and bipolar disorder can be determined from the nature of the episodes, duration and frequency, consciousness and awareness, motor symptoms, triggering and precipitating factors, as well as post-episode conditions.

Judging from its episodic nature, epileptic attacks are usually caused by abnormalities in the electrical activity of the brain, which are characterized by seizures, muscle twitches, or changes in consciousness and sensory disturbances. Meanwhile, bipolar disorder is a sporadic mental illness with symptoms of euphoria and high energy for a week or month followed by extreme sadness and despair. Considering their duration and frequency, epileptic seizures can last anywhere from a few seconds to a few minutes, and are not very common, whereas periods of bipolar disorder with abnormal mood can last for days to months, with intermittent periods. separated. normal mood. The duration and frequency of these mood episodes can vary greatly between individuals.

Regarding consciousness and consciousness, seizures can alter consciousness, causing loss of awareness and responsiveness during the episode, while individuals with bipolar disorder maintain full awareness and awareness during mood episodes. For motor symptoms, muscle stiffness, repetitive movements, or twitching are often experienced during epileptic attacks, whereas psychomotor symptoms in bipolar disorder are known to be the main characteristics of increased or decreased activity during manic or depressive episodes. These include agitation or retardation of movement. It is important to pay attention to the motor symptoms associated with this condition.

Triggers and precipitating factors for epileptic attacks are lack of sleep and stress, while bipolar disorder can be triggered by various factors including life events, sleep disorders, and changes in daily routine. Further differences in trigger factors between epileptic seizures and bipolar disorder can be seen in Table 1. In the post-episode state, after a seizure, sufferers may experience a post-tictal state characterized by confusion, fatigue, and memory impairment, whereas after a mood episode they experience a post-seizure state. In bipolar disorder, individuals often return to baseline levels of functioning,

Table 2 Differences in Precipitating Factors Between Epileptic Seizures and Bipolar Disorder

Trigger Factors	Bipolar disorder	Epilepsy
Emphasize*	✓ Strong evidence based on retrospective and prospective reports linking stress to mania may be due to endocrinological responses	✓ Strong evidence from retrospective and prospective reports linking stress to seizures. The most affected is the PS of the temporal lobe
Achievement of objectives Program*	✓ Susceptibility to mania-higher life ambitions. Higher levels of manic symptoms following goal attainment events	There is no proof
Emotion**	✓ Tentatively more evidence is required because it can confuse state and trait markers. Fun and entertainment = greater manic symptoms. Lability in those whose relatives express high levels of emotion	✓ In epileptic excitement, fear, anger and anxiety-the number of seizures is greater. Strongly related to PS in TLE
Sleep deprivation*	✓ Sleep deprivation serves as a marker for mania and depression. Animals and humans are associated with manic and manic-like behavior in bipolar disorder. Prospective evidence to support sleep deprivation and transition to mania	✓ Associated with focal seizures in TLE self-report. A seizure diary—to say the least A sleep reduction of 1.5 hours can cause more seizures
Moon phases	Associated with a high incidence of hospital admission. There is no direct evidence for bipolar disorder.	No effect on epileptic seizures, possible effect on non-epileptic seizures
Seasonal variations	✓ Spring and summer are associated with mania in bipolar disorder which may be caused by the effects of light and/or sleep deprivation	✓ Epileptiform discharge occurs more frequently in winter. Seizures are more common in winter focal seizures are less common on sunny days
Puberty/ menarche	Related to the beginning. There is no specific evidence that this is a triggering factor	Possible predisposing factors are inconsistent findings related to menarche
Period	Symptom fluctuations but not mania specifically, are strong candidates for future research	✓ Focal seizures in TLE—catamenial epilepsy
Postpartum	✓ Associated with mania and psychosis	Possible predisposing factors
Fairy/ menopause	Worsening/fluctuating symptoms require more research into hormonal levels verification. Possible predisposing factors	More research is needed on possible predisposing factors
Antidepressant Treatment*	✓The mechanism is unknown, suggesting a role for neurotransmitters in initiation mania	✓ Lowers the seizure threshold

* indicates the same precipitating factor in both disorders; **tentative precipitating factors ✓ indicates precipitating factor[18]

with periods of euthymia (normal mood).

A combination of clinical assessment, medical history, electroencephalogram (EEG) data, and, in certain situations, neuroimaging examination is usually used to make a diagnosis. However, the level of support for this technique can vary. An example of the application of this technique can be seen below; however, for any modification of diagnostic criteria or instruments, it is important to refer to the most recent research.

In differentiating epileptic seizures from bipolar disorder, several tools can be used to investigate them. These tools include clinical evaluation, ictal video encephalogram (EEG), neuroimaging studies (MRI, CTScan), and neuropsychological assessment. Clinical

evaluation by experienced neurologists and psychiatrists is considered essential for accurate diagnosis, although the level of evidence may be relatively lower due to its subjective nature. EEG, especially long-term video EEG monitoring (including ictal EEG), is an important tool in capturing and analyzing brain wave patterns during seizure events. This provides valuable information for diagnosing epileptic seizures.[6] Neuroimaging studies, such as magnetic resonance imaging (MRI) or computerized tomography (CT) scans, can help identify structural abnormalities in the brain and rule out certain causes of seizures.[11] Identifying specific patterns associated with mood disorders or epileptic seizures can be facilitated with the help of a neuropsychological assessment. This assessment is useful in evaluating cognitive function.20 Given the importance of a thorough evaluation, diagnosing such conditions often requires examination of the medical and family background, as well as the manifestation of certain indications.

Several studies have explored the application of different tools in diagnosing epileptic seizures and bipolar disorder. The seven articles included in this study provide insights into their advantages and disadvantages. For instance, neuroimaging techniques such as MRI and CT scans have been effective in identifying structural abnormalities, but their accessibility and high costs in certain regions limit their use.[6] Video-EEG monitoring is considered optimal for diagnosing psychogenic non-epileptic seizures (PNES), yet its availability remains a challenge in resource-limited settings.[11] Meanwhile, machine learning-based diagnostic tools have shown promise in improving accuracy and early detection, though concerns about data bias and interpretability need to be addressed.[9]

Recent genetic studies have identified potential biomarkers for both epilepsy and bipolar disorder. Article no. 3 highlights specific gene variants that may serve as new biomarkers. Among these, CACNA1C and SCN1A have been implicated in both conditions due to their roles in neuronal excitability and synaptic function.[8] The identification of such genes could pave the way for more precise diagnostic and therapeutic strategies, emphasizing the need for further genetic screening and validation studies.[9] Genetic testing should be considered in cases where a hereditary component is strongly suspected, particularly when there is a family history of epilepsy or psychiatric disorders. Specific gene variants have been identified as potential biomarkers for these conditions. The SCN1A gene has been primarily associated with epilepsy, particularly generalized epilepsies and Dravet syndrome, due to its role in neuronal excitability and sodium channel regulation.[8] Mutations in SCN1A can lead to hyperexcitability of neurons, increasing seizure susceptibility. On the other hand, the CACNA1C gene has been strongly linked to bipolar disorder, as it encodes a subunit of voltage-gated calcium channels that influence neuronal signaling and synaptic plasticity.[9] Studies have shown that variations in CACNA1C contribute to altered calcium channel function, which is implicated in mood regulation and psychiatric disorders, making it a key biomarker for bipolar disorder.

Additionally, immune system factors have been increasingly recognized as potential biomarkers for epilepsy. Article no. 1 discusses the role of pro-inflammatory cytokines, such as IL-6 and TNF-α, in epileptic conditions.[1] Elevated levels of these cytokines have been observed in epilepsy patients, suggesting an inflammatory component in seizure pathophysiology. These findings align with other studies emphasizing neuroinflammation as a critical mechanism in epilepsy, further supporting the potential role of immune biomarkers in diagnosis and treatment strategies.[10] Future studies should explore how these immune markers interact with genetic predispositions to refine diagnostic accuracy and therapeutic approaches.

Given the evolving landscape of epilepsy and bipolar disorder diagnostics, integrating multimodal approaches—including neuroimaging, genetic screening, immune profiling, and machine learning—may significantly enhance clinical decision-making. However, challenges such as accessibility, cost, and validation of new biomarkers need to be addressed through collaborative interdisciplinary research efforts.

Differentiating epileptic seizures from bipolar disorder presents persistent challenges for clinicians and researchers. Accurate distinction is essential for effective management and improved patient outcomes, yet both conditions share overlapping symptoms, genetic predispositions, and environmental triggers. Recognition of these similarities underscores the need for comprehensive and multidisciplinary assessment. Collaboration among specialists in neurology, psychiatry, and neuropsychology is fundamental to refining diagnostic strategies.

Recognition of the similarity of symptoms, genetic predisposition, and environmental

triggers between epileptic seizures and bipolar disorder underscores the need for differentiated and comprehensive assessment. Genetic testing should be considered in cases where a hereditary component is strongly suspected, particularly when there is a family history of epilepsy or psychiatric disorders. Specific gene variants, such as CACNA1C and SCN1A, have been associated with both conditions and may serve as potential biomarkers to refine diagnosis and tailor treatment strategies.[8,9] Similarly, video-electroencephalogram (vEEG) should be used in cases where non-epileptic seizures are suspected, such as psychogenic non-epileptic seizures (PNES), or when routine EEG findings are inconclusive.[11] vEEG remains a critical tool in capturing ictal events and distinguishing between epileptic and non-epileptic seizures, particularly in patients with atypical presentations or treatment-resistant cases.[6,7]

This review is limited by heterogeneity in diagnostic techniques, lack of quantitative synthesis, and potential publication bias, which restrict generalizability. Furthermore, while emerging biomarkers and neuroimaging hold promise, their clinical validation remains incomplete and requires large-scale studies.

Future research should integrate genetic, neuroimaging, and immunological biomarkers to enhance diagnostic accuracy and support individualized treatment planning. Continued interdisciplinary collaboration and technological advances are essential for developing standardized frameworks that improve patient care and quality of life.

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