

Artificial Intelligence in Schizophrenia: Where We Stand?

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Abstract

Schizophrenia is a severe, chronic mental health condition affecting the lives of millions of people universally. The unclear pathological mechanisms of the disorder and its heterogeneity and complexity make its diagnosis and treatment challenging. The lack of objectively measurable diagnostic tests for schizophrenia further decreases the reliability of its diagnosis. Artificial intelligence techniques have the potential to provide an objective and evidence-based approach to the identification and management of schizophrenia. This article reviews the current understanding of its current use in schizophrenia, advantages, disadvantages and future potentials. With the passage of time and digitalization of the modern age, there will be an increase in the use of artificial intelligence in psychiatry hence a detailed understanding will be thoughtful. For this, we searched search engines, by using keywords. Initial searches involved the use of each individual keyword while the later searches involved the use of more than one word in different permutation combinations.

Keywords: Schizophrenia • Artificial intelligence • Machine learning • Mental health

Introduction

Schizophrenia is a severe, chronic mental health condition that affects the lives of millions of people universally causing significant impairment of quality of life [1].

The early onset of the disease, together with its atrocious course, makes it an incapacitating disorder for many patients and their caregivers. The symptoms of schizophrenia can be categorized into three groups, namely positive, negative or cognitive symptoms. Clinical evaluation is done based on these observed symptoms and probative reports. At present, it is diagnosed clinically by fulfilling the criteria as stated by either the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-V) or the International Classification of Diseases 11th Revision (ICD-11). Treatment of schizophrenia is generally classified under two categories-non-pharmacological and pharmacological. Non-pharmacological interventions seek to aid patients to cope with their symptoms and attain a sustainable level of psychosocial functioning. While the cornerstone of therapy remains pharmacological interventions, which are bottomed on neurobiological theories of re-uptake and release of neurotransmitters [2].

The unclear pathological mechanisms of the disorder and its heterogeneity and complexity make its diagnosis and treatment challenging. The lack of objectively measurable diagnostic tests for schizophrenia further decreases the reliability of its diagnosis [3].

In this context, applying artificial intelligence techniques has the potential to provide an objective and evidence-based approach to the identification and management of schizophrenia [4].

Artificial Intelligence (AI) is the science and engineering of making computers (machines) solve problems and behave in ways normally considered to be intelligent or distinctive to human intelligence [5]. The different subsets or approaches to Artificial intelligence consists of machine learning, deep learning, and transfer learning. Machine learning is the study of computer algorithms that upgrade automatically through events and by the use of data [6].

As a part of machine learning, an Artificial Neural Network (ANN) is a brain-influenced algorithm that consists of layers with connected nodes. Recent time's researchers are focused on expanding Artificial Neural Network (ANN) into DNN (Deep Neural Network) by stacking multi-hidden layers with connected nodes between input and output layers.

The multilayer can approach more complex problems by devising simple decisions between layers. Deep Neural Network (DNN) usually shows finer performance than the shallow layered network in prediction tasks such as categorization [7].

While the field of medicine has made remarkable progress in the domain of artificial intelligence, the field of psychiatry has been slow to adopt it, but it is catching up and delivering promising results.

Review of Literature

In this brief review, we searched for articles, conferences, and review papers using keywords such as 'Schizophrenia', 'Artificial Intelligence', 'Machine Learning', 'Deep Learning', 'Mental Health', 'Detection', 'Diagnosis' and its variants. The resulting literature was screened for relevance before being chosen to be included in this review. The search was guided to address the research questions and involved the use of more than one word in different permutation combinations. The relevant references were selected. The information was retrieved from these articles as concepts, which are discussed under different pre-defined sections, based on the research questions.

1. What is the role of artificial intelligence in early diagnosis and prediction of Schizophrenia?
2. What is the current status/application of AI in management of Schizophrenia?
3. What are the limitations and gaps in knowledge of AI applications in Schizophrenia?

The purpose of this article is to review the uses, efficacy, and limitation of artificial intelligence techniques in diagnosing, predicting clinical outcomes, management, and future research related to schizophrenia.

Artificial intelligence in early diagnosis and prediction of schizophrenia

Schizophrenia customarily succeeds a prodromal phase with attenuated schizophrenia-like symptoms. It is estimated that ~30% of patients in a prodromal phase convert to psychosis within a 3-year follow-up period [8]. Artificial intelligence systems can predict the risks of conversion and relapse, allowing timely interventions [9].

Artificial Neural Network (ANN) models have been used to predict

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psychosis from the poverty of content and talking about voices, in speech samples [10,11]. Some studies have used Artificial intelligence systems on large Electronic Health Records (EHRs) to prognosticate the onset of schizophrenia with very good results [12]. Apart from these artificial intelligence techniques have been used in various neuroimaging methods for the detection of schizophrenia. Machine learning algorithms have been used to detect schizophrenia from healthy controls by comparing grey matter and white matter with corresponding size and density, with great precision [13]. The Functional Magnetic Resonance Imaging (fMRI) data on the neural network have accurately demonstrated that patients with schizophrenia appear to activate a less unique set of brain regions [14]. Several studies on artificial intelligence techniques on Electrocardiogram (ECG) scans have been used to predict psychosis with exactness ranging from 74% to 93% [15-22]. Facial features are also an area of interest to detect schizophrenia such as eye-tracking [23] and facial expressions [24,25] as well as communication ability by tracking handwriting detecting [26] or tracking keywords used on social media [27]. Artificial intelligence techniques have also been used to predict the risk of schizophrenia in healthy first-degree relatives [28].

Artificial intelligence and management of schizophrenia

Artificial intelligence presents new opportunities for management in psychiatry. Based on specific changes in brain volume, several groups have shown that machine learning can distinguish non-medicated, first-episode patients with schizophrenia from healthy controls using Volumetric Magnetic Resonance Imaging (vMRI) data [29].

Avatars have been successfully used in the treatment of schizophrenia, to improve medication adherence [30].

Similar to the Avatar Project, virtual reality assisted therapy for schizophrenia usually encourages patients to engage with the voices they hear through the use of an artificial intelligence avatar. Studies have found that this therapy could help in developing therapeutic targets [31].

Virtual reality therapy has helped in the improvement of symptoms like visual and auditory hallucinations, depressive symptoms, and overall quality of life particularly in difficult cases of schizophrenia, like treatment-resistant schizophrenia patients [32]. Artificial intelligence-based Robot-assisted therapy has also been tried on patients with great success [33].

Apart from aiding in the treatment of psychosis, Machine learning methods have been used to predict treatment response in patients with schizophrenia using Magnetic Resonance Imaging (MRI) and polygenic scores [34,35] and have efficiently assessed compliance and adherence to antipsychotic treatment [30].

With an increasing demand for precision medicine in recent times, studies have used Machine learning to develop individualized treatment rules for patients with schizophrenia with a more than 50% treatment success rate [36]. Along with individualized treatment, strategies for the individualized assessment using machine learning techniques have successfully identified violent behavior in patients with schizophrenia using neuroimaging data [37].

Advantages and limitations of artificial intelligence in schizophrenia

Artificial intelligence-supported diagnostic tools aim at improving diagnostic confidence, may deliver an automated second opinion, corroborate a psychiatrist's judgment, and assist with uncertain cases. Considering the difficulty of establishing whether schizophrenia is precisely diagnosed and given the considerable inter-rater disagreement among experts, a diagnostic algorithm bracing psychiatrists in their decision-making could increase the plausibility of patients receiving an unerring diagnosis and hence of receiving adequate treatment and prevention of irrelevant psychopharmacological interventions [38,39].

However, artificial intelligence does not come without its drawbacks. In the field of psychiatry where empathy and compassion play a pivotal role, artificial intelligence lacks it predominantly. With a dearth of adequate data protection systems and laws, artificial intelligence systems might act as a

gateway for hacking and unauthorized monitoring. Also, there is potential for over-dependency of both the patient and doctor on artificial intelligence systems [40-42].

Conclusion

The drastic insurgence of artificial intelligence that has been occurring during the last few years is changing how we perceive and treat schizophrenia. Our potential to extract utilitarian information from high-dimensional and multimodal data has been enhanced considerably. Likewise, the accuracy of automatic data-based diagnosis and outcome prediction systems is superior to before. These algorithms can increase our capacity for executing prophylactic or further effective personalized treatment interventions. Although these systems can aid us to mollify some of the burden of schizophrenia on patients and caregivers, they may introduce multiple ethical problems that need to be carefully assessed and handled. Additionally, considering the negative impact that a misdiagnosis or erroneous prediction may have on a patient's life, artificial intelligence systems will require continuous error evaluation and suitable protocols to defend the welfare of people.

In summary, the functioning of artificial intelligence systems in Schizophrenia is limited; however its greater advancements and applications are expected in near future. Lastly! The author hoping with enthusiasm that the artificial intelligence systems framework can be set to aid in making the current medical treatment more efficient and accessible as far as Schizophrenia is concerned.

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