International Journal of
Brain Sciences

ISSN: 3048-7935
Volume 3, Issue 2, 2026
July-December
DOI (Journal): 10.37591/IJBS

https://journals.stmjournals.com/ijbs

Research IJBS

Artificial Intelligence in Early Diagnosis and Personalized Treatment of Alzheimer's Disease

Rohit Saroha[1,*], Chetna Chhabra[2], Abhishek Kumar[3], Gauri Mudgal[4]

Abstract

Artificial intelligence (AI) has become a disruptive technology in the medical care industry, with potential solutions to early diagnosis and customized treatment of Alzheimer's disease (AD), a progressive neurodegenerative disease and the most prevalent cause of dementia globally. Conventional diagnostic techniques, such as cognitive, neuroimaging and biomarker techniques, are usually limited in the ability to detect disease at its most susceptible stage when treatment interventions are most effective. The recent developments in AI, specifically machine learning, deep learning, natural language processing, and predictive analytics, have greatly enhanced the capacity to detect subtle patterns of diseases influenced by complex multimodal data. The AI analysis of magnetic resonance imaging (MRI), positron emission tomography (PET), cerebrospinal fluid biomarkers, blood biomarkers, genomic data, speech patterns, and digital health data has shown incredible prospects of improving the diagnostic accuracy and allowing early detection of the Alzheimer disease. In addition, AI can facilitate precision medicine by combining both patient-specific clinical, genetic, environmental, and lifestyle data to create personalized treatment approaches and maximize therapeutic decision-making. Innovative uses of AI, including treatment planning, disease progression forecasting, digital therapeutics, wearables, and remote monitoring are all part of increasingly proactive and patient-centered healthcare provision. Explainable AI is also enhancing the transparency and clinical acceptance of AI-based decision-support systems. Notwithstanding its promising prospects, issues concerning data privacy, algorithm bias, interpretability, regulatory approval, and clinical validation should be considered as crucial factors to the wider implementation. This review provides an overview of the existing uses of artificial intelligence in early diagnosis and personalized treatment of Alzheimer disease, emphasizing recent technological developments, clinical uses, current limitations and opportunities. Further adoption of AI in neurology can transform the care of dementia using predictive, preventive, and tailored healthcare practices that enhance patient outcomes and quality of life.

***Author for Correspondence**
Rohit Saroha
E-mail: rsaroha44@gmail.com

[1]Assistant Professor, Department of Physiology, Venkateshwara Institute of Medical Sciences, Gajraula, Amroha, Uttar Pradesh, India
[2]MD Resident, Department of Medicine, Santosh Deemed to be University, Ghaziabad, Uttar Pradesh, India
[3]Assistant Professor, Department of Pharmacy, Acharya Dhrubhasa College of Health Care Education, Sitamarhi, Bihar, India
[4]PhD Scholar and Assistant Professor, Department of Physiology, Divya Jyoti College of Dental Sciences and Research, Modinagar, Uttar Pradesh, India

Received Date: June 04, 2026
Accepted Date: June 13, 2026
Published Date: June 25, 2026

Citation: Rohit Saroha, Chetna Chhabra, Abhishek Kumar, Gauri Mudgal. Artificial Intelligence in Early Diagnosis and Personalized Treatment of Alzheimer's Disease. International Journal of Brain Sciences. 2026; 3(2): 15–27p.

Keywords: Alzheimer's Disease, Artificial Intelligence, Machine Learning, Early Diagnosis, Precision Medicine

INTRODUCTION

Alzheimer disease (AD) is a progressive neurodegenerative disorder and the cause of dementia most prevalent in the world with the prevalence rate of about 60–80 percent of all dementia disorders. It is typified by a slow decline in memory, cognition, language and behavioural functions, which eventually leads to critical functional impairment and loss of autonomy [1]. The prevalence of the Alzheimer disease is on the rise worldwide as the aging of population has led to millions of victims and the healthcare systems are experiencing significant economic and social impacts. The disease has been neuropathologically linked to extracellular amyloid-B plaque accumulation, intracellular neurofibrillary tangles that contain hyperphosphorylated tau proteins, synaptic dysfunction and progressive neuronal loss (Figure 1) [2].

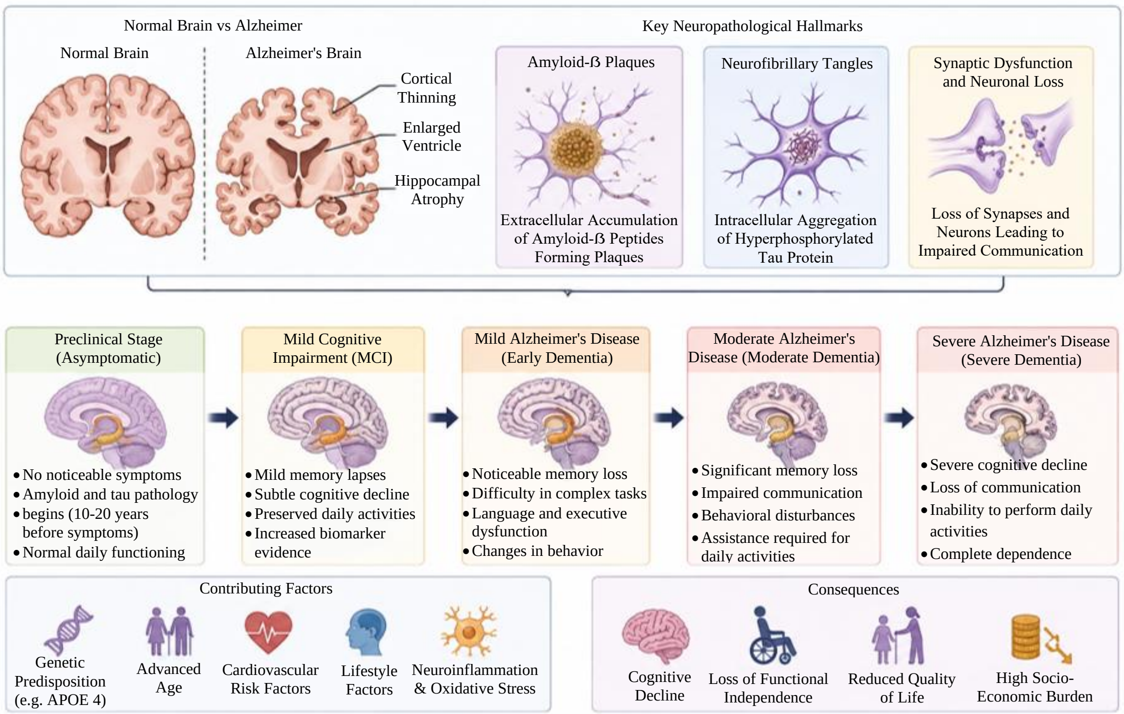

Figure 1. Pathophysiology and progression of Alzheimer's disease.

Although neuroscience has made great progress in its research, early diagnosis is a major problem as the pathological changes usually start many years or even decades before clinical symptoms appear [3]. The classic diagnostic methods, such as cognitive tests, neurological tests, the analysis of cerebrospinal fluid biomarkers, and the use of neuroimaging methods, such as magnetic resonance imaging (MRI) and positron emission tomography (PET, etc.), have been shown to enhance the accuracy of diagnosis, but they have limited effectiveness in the early detection of disease due to their inaccessibility, high costs, interpretation, and sensitivity [4]. This has led to the increased demand in the innovative technologies that can detect subtle changes associated with diseases before it is too late and the neurons are damaged irreversibly. Artificial intelligence (AI) is a revolutionary technology in healthcare that has become a viable tool in recent years with its sophisticated computational methods of data analysis, pattern recognition, prediction, and decision support [5]. AI includes machine learning, deep learning, natural language processing, and other data-driven approaches that are highly efficient in handling large and complex data sets. AI has shown promise in Alzheimer disease research through the analysis of multimodal data collected through neuroimaging, genetic profiles, fluid biomarkers, electronic health records, speech patterns, and wearable devices to help diagnose the disease earlier and more accurately [6]. Machine learning algorithms are able to detect small structural and functional brain abnormalities that may not be evident using traditional methods of assessment, and deep learning models are highly accurate in differentiating between healthy participants and those with mild cognitive impairment and Alzheimer disease [7]. Moreover, AI is becoming a more significant part of personalized medicine as it can combine clinical, genetic, environmental, and lifestyle variables to create an individualized treatment plan specific to the unique disease profile of a patient. Predictive models based on AI have the potential to predict disease progression, optimize therapeutic interventions, aid drug discovery, and allow continuous remote monitoring of patients, leading to better clinical outcomes and quality of life [8]. New AI developments, like explainable AI and digital therapeutics, smart healthcare ecosystems, and so on, are likely to be further developed to optimize the diagnosis and treatment of Alzheimer disease in the future [9]. Even though issues surrounding data privacy, ethical aspects, and transparency of algorithms, as well as clinical validation, continue to be substantial, the introduction of artificial intelligence into dementia care is a bright step toward precision neurology. Thus, it is crucial to comprehend the uses, advantages, drawbacks, and future opportunities of AI in the early detection and customized treatment of Alzheimer disease as the way to further the patient-centred care and enhance the long-term management of the disease [10].

ALZHEIMER'S DISEASE: OVERVIEW AND CURRENT CHALLENGES

Alzheimer disease (AD) is a progressive, neurodegenerative disorder that is chronic and most commonly causes dementia, which causes about 60–80 percent of dementia cases in the world. It is marked by a slow deterioration of memory, cognitive functions, language, reasoning and behavioural functions and eventually, total dependence and death [11]. Alzheimer disease has a multifactorial pathophysiology, which includes aggregation of extracellular amyloid-b (A8) plaques and intracellular neurofibrillary tangles, consisting of hyperphosphorylated tau protein, that interferes with neuronal communication, triggers synaptic dysfunction, neuroinflammation, oxidative stress, mitochondrial dysfunction, and general neuronal loss [12]. The main locations of such pathological changes are the hippocampus and cerebral cortex where memory is formed, and higher cognitive functions are carried out. There is evidence that amyloid deposition can start decades prior to the clinical phenotype, and then tau-pathology, neuronal death, and brain atrophy develop. Genetic factors, such as mutations in the APP, PSEN1, PSEN2 genes and the existence of APOE ε4 allele, do play a major role in disease susceptibility and progression, whereas aging, cardiovascular disease, diabetes, obesity, physical inactivity and environmental factors also contribute to the development of the disease [13]. The Alzheimer disease has become one of the biggest public health issues in the twenty first century because of the high rate of aging around the world. Recent estimates show that over 55 million individuals around the world have dementia, the largest percentage of which is Alzheimer disease and this figure is expected to go beyond 139 million by 2050 unless effective preventive and therapeutic measures are put in place [14]. The disease has colossal socioeconomic effects on patients, families, caregivers, and healthcare systems due to higher healthcare spending, lifetime care needs, low productivity and a high level of emotional distress. Demographic changes and inadequate healthcare facilities are set to affect the prevalence of diseases in the low- and middle-income countries in the most significant way [15]. Although there is extensive progress in the comprehension of disease mechanisms, early and correct diagnosis is a significant challenge. Traditional methods of diagnosis use mostly clinical history, neuropsychological testing, neurological examination, analysis of cerebrospinal fluid biomarkers, and neuroimaging (magnetic resonance imaging (MRI) and positron emission tomography (PET) [16]. Despite the fact that these techniques have enhanced the diagnostic accuracy, they have a number of limitations that include high costs, inaccessibility, invasive nature, inter-observer variability and sensitivity in the detection of preclinical stages of the disease [17]. The cognitive assessment tools cannot detect subtle impairment in the initial stages of disease progression and imaging and biomarker analyses can be more expensive and specialized equipment and expertise and may not be easily accessible in normal clinical scenarios. Moreover, the heterogeneity of Alzheimer disease leads to a great deal of variation in the symptoms manifestation and development of the disease, which makes it difficult to diagnose and plan treatment [18]. These drawbacks underscore the necessity of novel diagnostic and therapeutic measures that can be used to detect alterations related to the disease at an early stage before the neurons have been damaged irreparably to enhance patient outcomes and help establish individualized treatment programs to patients with Alzheimer's disease [19].

ARTIFICIAL INTELLIGENCE IN HEALTHCARE

Artificial intelligence (AI) has become one of the most revolutionary technologies in contemporary healthcare, transforming the process of diagnosis, monitoring, treatment, and prevention of diseases with the help of the analysis of large and complicated data that cannot be processed by humans. AI is a set of computational systems, which can simulate the human cognitive processes of learning, reasoning, problem-solving and decision-making [20]. AI is used in healthcare to extract meaning in medical data that clinicians can use, via machine learning (ML), deep learning (DL), natural language processing (NLP), computer vision and predictive analytics [21]. Machine learning algorithms can make a system learn based on historical data and do even better without explicit programming, whereas deep learning involves the use of multilayered neural networks that have the capability of detecting intricate patterns in large datasets automatically. The popular machine learning methods are Support Vector Machines (SVM), Random Forests (RF), Logistic Regression (LR), and clustering algorithms, but the methods of deep learning are Artificial Neural Networks (ANNs), Convolutional Neural Networks (CNNs), and Recurrent Neural Networks (RNNs), and each of them has proved to be highly useful in healthcare applications (Table 1) [22]. These technologies have greatly contributed to improved accuracy in diagnostic, predictive modeling and clinical decision making in different medical disciplines with integration. Due to the complexity and heterogeneity of the disease pathology that is a combination of genetic, molecular, imaging, and clinical factors, AI has gained a growing role in Alzheimer disease research. Subtle patterns related to disease can be discovered using machine learning algorithms, by examining large multimodal datasets gathered by neuroimaging studies, cerebrospinal fluid biomarkers, blood biomarkers, genomic analyses and electronic health records that would otherwise be hidden using traditional analytical approaches [23]. Deep learning algorithms, especially CNNs, have demonstrated impressive achievements in decoding magnetic resonance imaging (MRI) and positron emission tomography (PET) images of the early stages of Alzheimer disease and mild cognitive impairment. Equally, SVM and Random Forest algorithms have been extensively used to classify diseases, select biomarkers, predict risks, and NLP techniques can be used to analyse speech and language impairments related to cognitive decline (Table 1). The increasing use of AI in the study of Alzheimer disease indicates its potential in enhancing the early identification, disease management, and individualized treatment plans. In addition to the Alzheimer disease, AI has proven to be of significant value in a broad spectrum of neurological conditions such as Parkinson, epilepsy, multiple sclerosis, amyotrophic lateral sclerosis, stroke, and brain tumors. AI-based systems help clinicians with automated image interpretation, lesion detection, prediction of seizures, prediction of disease progression, and optimization of treatment [24]. High-end deep learning algorithms are sensitive and fast to detect subtle neuroanatomical variations linked to neurological diseases than conventional methods, thus enabling timely intervention and better patient outcomes. Moreover, the wearable hardware combined with AI-based algorithms will allow continuous tracking of motor activity, cognitive functions, sleep, physiological parameters and provide real-time information on disease progression and therapeutic response. Adaptive treatment planning and personalized healthcare delivery is also under investigation using reinforcement learning approaches, and explainable artificial intelligence aims to enhance transparency and clinician trust in AI-generated recommendations (Table 1) [25].

Table 1. Major artificial intelligence techniques used in Alzheimer's disease research.

AI technique	Category	Principle	Applications in Alzheimer's disease	Advantages	Limitations
Support Vector Machine (SVM)	Machine Learning	Classifies data by identifying optimal decision boundaries between groups	Early diagnosis, classification of AD, MCI, and healthy individuals	High accuracy with small datasets	Limited performance with very large datasets.
Random Forest (RF)	Machine Learning	Ensemble of multiple decision trees for prediction and classification	Biomarker identification, disease prediction, feature selection	Robust and less prone to overfitting	Reduced interpretability.
Logistic Regression (LR)	Machine Learning	Statistical model estimating probability of disease occurrence	Risk prediction and patient stratification	Simple and easy to interpret	Limited ability to model complex relationships.
Artificial Neural Networks (ANNs)	Deep Learning	Mimics interconnected neurons to learn complex patterns	Cognitive decline prediction and disease classification	Handles nonlinear relationships effectively	Requires large training datasets.

Convolutional Neural Networks (CNNs)	Deep Learning	Automatically extracts features from imaging data	MRI and PET image analysis, early detection of AD	High accuracy in image recognition	Computationally intensive.
Recurrent Neural Networks (RNNs)	Deep Learning	Processes sequential and temporal data	Disease progression prediction and longitudinal analysis	Effective for time-series data	Risk of vanishing gradient problems.
Natural Language Processing (NLP)	AI Technique	Analyzes and interprets human language and speech	Speech analysis and early cognitive impairment detection	Non-invasive and cost-effective	Influenced by language and cultural variations.
Clustering Algorithms	Unsupervised Learning	Groups similar data points without predefined labels	Patient subgroup identification and phenotype discovery	Reveals hidden patterns in datasets	Results may be difficult to interpret.
Reinforcement Learning	Advanced AI	Learns optimal actions through feedback mechanisms	Personalized treatment planning and decision support	Supports adaptive interventions	Limited clinical implementation.
Explainable AI (XAI)	Advanced AI	Provides transparent and interpretable AI decisions	Clinical decision support and diagnostic validation	Improves trust and transparency	Still under active development.

Despite the importance of data privacy issues, algorithm bias, and model interpretability, as well as clinical validation as the main obstacles to the mass adoption of AI, the latter still revolutionizes the field of neurological healthcare, enhancing the accuracy of diagnosis results, allowing personalized medicine and assisting with the evidence-based use of clinical judgment, thus becoming one of the keystones of future neurology research and patient care [26].

AI-BASED EARLY DIAGNOSIS OF ALZHEIMER'S DISEASE

Early detection of the Alzheimer disease (AD) is important to achieve a timely intervention, reduce the rate of disease progression, enhance patient outcomes, and ensure a patient receives a personal approach to treatment. Nevertheless, the traditional methods of diagnosis frequently cannot reveal the presence of slight pathological alterations during the preclinical and prodromal phases of the disease. Recent developments in artificial intelligence (AI) have played an important role in improving the capacity to detect early biomarkers and disease related patterns by combining neuroimaging, molecular, clinical, and behavioural data [27]. The AI-based early diagnosis workflow is generally characterized by the following steps: the data acquisition, pre-processing, feature extraction, model training, validation, and clinical prediction, which allows identifying high-risk individuals prior to the appearance of overt cognitive manifestations (Figure 2).

Neuroimaging analysis is one of the most popular tools that have become one of the pillars of AI-assisted diagnosis as it allows visualizing structural and functional brain changes related to Alzheimer disease. Magnetic Resonance Imaging (MRI) can give detailed data about cortical atrophy, loss of hippocampal volume, ventricular enlargement, and white matter abnormality, and AI algorithms including convolutional neural networks (CNNs), support vector machines (SVMs), and deep learning structures can automatically identify subtle changes in the anatomy with high diagnostic accuracy [28]. Positron Emission Tomography (PET) is a complement to MRI that provides the opportunity to visualize the deposits of amyloid-beta, tau pathology, glucose metabolism, and neuronal activity, which AI systems can detect to identify disease-specific patterns that do not emerge when using conventional image analysis. In addition to neuroimaging, biomarker detection and prediction have gained importance in the study of Alzheimer disease [6]. Cerebral biomarkers, blood-based biomarkers, genomic, proteomics, metabolomics, and transcriptomics can be pooled into complex datasets that AI algorithms can analyze to determine predictive signatures that relate to disease onset and progression [29]. Machine learning models can be used to combine multimodal biomarker data, thus enhancing diagnostic sensitivity and specificity in comparison to conventional single-marker diagnostics. Another field of AI-assisted diagnosis that at the moment is being developed at a very fast pace is speech and language analysis where fine changes in speech fluency, use of vocabulary, semantic processing, and language structure can be observed in the very early stages of cognitive impairment [9]. NLP methods can be used to analyze samples of verbal and written language and identify linguistic abnormalities that are signs of mild cognitive impairment and Alzheimer disease. Equally, AI-based cognitive assessment apps are being used more often to test memory, attention, executive functioning, and problem-solving skills using digital platforms and automated testing applications as objective and scalable alternatives to traditional neuropsychological assessments [30]. Moreover, with the advent of digital biomarkers and wearable devices, new possibilities of ongoing tracking of cognitive and behavioral alterations in the real-life context have become possible. Longitudinal data on mobility, sleep patterns, physical activity, social interactions, and physiological parameters can be gathered by smart devices, wearable sensors, smartphones, and systems based on the Internet of Things (IoT) and analyzed using AI algorithms to determine early signs of the disease progression. The mentioned technologies have a high level of benefit as they allow tracking individuals remotely, decreasing the clinical load, and promoting the provision of care on the personal level [31].

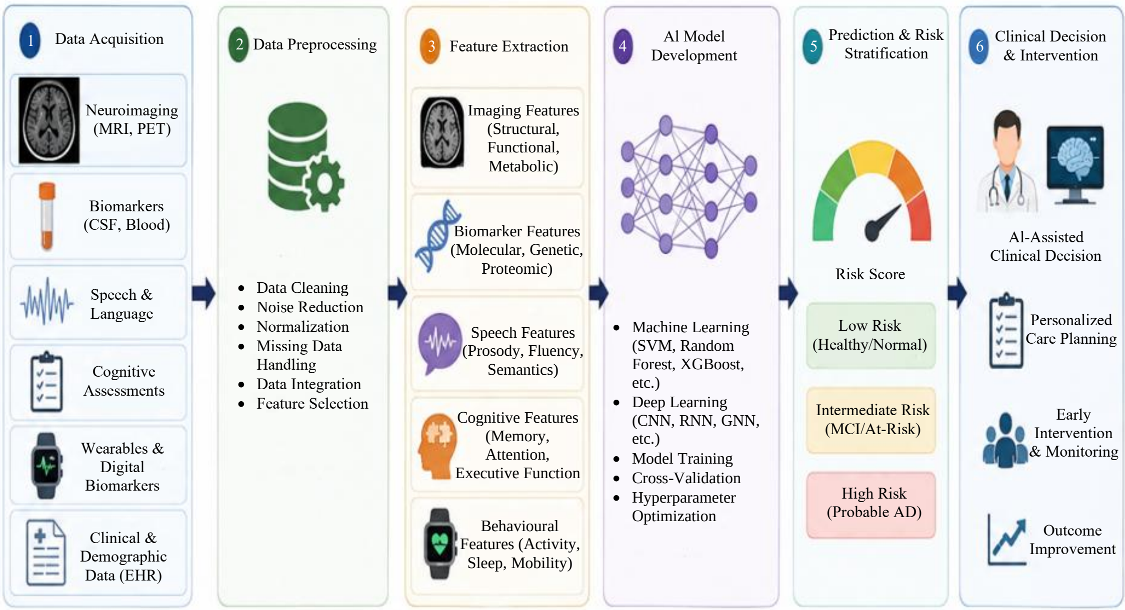

Figure 2. Workflow of AI-based early diagnosis of Alzheimer's disease.

Table 2 provides an overview of various AI-based diagnostic tools that are currently used in the study and clinical practice of Alzheimer disease and their respective applications and benefits. Together, these developments show the potential of artificial intelligence, which can be used to transform the process of diagnosing the Alzheimer disease earlier, more accurately, and in a more personalized way, which will ultimately lead to better patient care and management of the disease.

Table 2. AI-based diagnostic tools and their clinical applications.

Diagnostic tool / technology	AI technique used	Data source	Clinical application	Key outcome
MRI-Based Diagnostic Systems	CNN, Deep Learning	Structural MRI Images	Detection of hippocampal atrophy and brain volume loss	Early identification of Alzheimer's disease.
PET Image Analysis Platforms	CNN, Machine Learning	PET Scans	Detection of amyloid-β plaques and tau pathology	Improved diagnostic accuracy.

Computer-Aided Diagnosis (CAD) Systems	SVM, Random Forest	Neuroimaging Data	Automated classification of AD, MCI, and healthy individuals	Faster and more reliable diagnosis.
Biomarker Prediction Models	Machine Learning Algorithms	CSF and Blood Biomarkers	Identification of disease-specific biomarkers	Early risk prediction.
Genomic Analysis Platforms	AI-Based Predictive Models	Genetic and Genomic Data	Detection of genetic susceptibility factors	Personalized risk assessment.
Natural Language Processing (NLP) Systems	NLP, Deep Learning	Speech and Language Samples	Identification of cognitive and linguistic impairments	Non-invasive early screening.
Digital Cognitive Assessment Tools	Machine Learning	Cognitive Test Data	Evaluation of memory and executive functions	Automated cognitive assessment.
Wearable Sensor-Based Monitoring Systems	AI Analytics, Deep Learning	Activity and Physiological Data	Continuous monitoring of behavioral changes	Early detection of functional decline.
Smartphone-Based Digital Biomarker Platforms	Machine Learning	Mobile Device Usage Data	Monitoring cognitive and behavioral patterns	Remote patient assessment.
Electronic Health Record (EHR) Analytics	Machine Learning, Predictive Analytics	Clinical Records	Prediction of disease progression and outcomes	Clinical decision support.

PERSONALIZED TREATMENT STRATEGIES USING ARTIFICIAL INTELLIGENCE

The increasing heterogeneity in the onset, progression, clinical presentation, genetic predisposition, and response to therapy of Alzheimer disease (AD) has resulted in the increasing importance of personalized treatment strategies in managing the disease. Conventional techniques of treatment are usually one-size-fits-all, which does not consider all these individual differences, thus giving inconsistent clinical results and making the treatment ineffective [32]. Artificial intelligence (AI) has become an influential facilitator of precision medicine, using a variety of sources of patient-specific data, such as genetic profiles, neuroimaging findings, biomarker data, clinical histories, environmental exposures, and lifestyle characteristics, to aid in individualized healthcare decisions [9]. Precision medicine methods are machine learning and deep learning algorithms that can be used to determine disease subtypes, forecast response to treatment, and can be used to develop personalized intervention strategies based on the unique biological and clinical characteristics of the patient [33]. Precision medicine AI in Alzheimer disease In Alzheimer, multimodal data is intricate and analysis can be performed to identify patients at a higher risk, the most effective treatment route, and enhance prognostic accuracy. Another vital aspect of personalized medicine is pharmacogenomics, which is concerned with the effect of genetic differences on drug metabolism, efficacy, and toxicity [34]. Pharmacogenomic models based on AI have the potential to analyze genomic data to predict genetic markers of therapeutic response and adverse drug reactions, thus allowing clinicians to choose the best medications and dosages to use with specific patients. These strategies can enhance the efficacy of treatment with a minimum of side effects especially in geriatric populations where polypharmacy is a common occurrence [35]. The combination of AI, genomics, biomarkers, and clinical data into a tailored treatment model offers a holistic approach to patient care optimization and improvement of clinical outcomes. The use of AI in the planning of treatment also expands the scope of artificial intelligence in the Alzheimer disease management process by aiding in evidence-based clinical decision-making. State-of-the-art machine learning techniques can process and analyze big patient data and provide treatment suggestions, including the disease stage, mental condition, comorbidities, biomarker profiles, and past treatment results. Such systems allow the medical community to consider various treatment options at the same time and find treatments that have the highest chances of helping individual patients [9]. Along with the choice of treatment, AI is especially important to predict the development of the disease by creating predictive models that can estimate the future impairment of the cognitive and functional processes, as well as the transition of mild cognitive impairment to Alzheimer. These models can predict disease trajectories with greater precision by utilizing longitudinal clinical, imaging, and biomarker data, and thus enable early intervention and long-term care planning. Predictive analytics also facilitates identifying patients who can be taken to clinical trials and new line of therapy [36]. Moreover, remote monitoring and smart care systems have changed the way the Alzheimer disease is managed using wearable sensors, smartphone applications, Internet of Things (IoT) devices, and digital health platforms to continually gather real-time data on physical activity, sleep habits, cognitive functioning, medication compliance, and behavior modification. AI algorithms process these data streams to identify subtle anomalies in normal operation to enable clinicians and caregivers to take action before the situation degrades considerably [37]. These technologies facilitate active management of diseases, decrease hospitalization, increase patient safety and quality of life besides making aging in place possible. All these new technologies in combination are a revolutionary paradigm in the treatment of Alzheimer disease, providing increasingly personalized, efficient, and patient-centred treatment plans, which can enhance long-term clinical outcomes and help to develop precision neurology [38].

CLINICAL APPLICATIONS AND RECENT ADVANCES

The use of artificial intelligence (AI) in clinical settings with Alzheimer disease (AD) has grown exponentially in the last 10 years, and more recently, it has been shown to substantially advance the diagnosis of the disease, risk assessment, the identification of biomarkers, treatment regimens, and monitoring the patients. In 2020–2026, many articles have indicated the prospect of machine learning, deep learning, natural language processing, and predictive analytics to revolutionize traditional methods of treating Alzheimer disease [39]. Among the most notable clinical AI uses is the early diagnosis of disease by examining neuroimaging data collected due to magnetic resonance imaging (MRI) and positron emission tomography (PET). Deep learning models and specifically convolutional neural networks (CNNs) have demonstrated high diagnostic accuracy based on their ability to detect subtle structural and functional brain abnormalities that can be challenging to identify using conventional image interpretation [40]. Several recent studies have indicated that AI-aided neuroimaging analysis can discriminate between healthy and sick people with mild cognitive impairment and Alzheimer disease with an impressive sensitivity and specificity. Along with neuroimaging, AI-based biomarker discovery has emerged as a key field of study, allowing molecular, genetic, proteomic, and metabolic biomarkers of disease initiation and progression to be identified [41]. Multimodal sets of biomarkers have been effectively incorporated by machine learning algorithms to enhance disease prediction and personalized risk evaluation. Another focus of recent research has been the increasing importance of blood-based biomarkers that are processed through AI-driven analytical algorithms and provide fewer invasive options instead of cerebrospinal fluid analysis and costly imaging methods. Another area of research in Alzheimer disease, speech and language assessment, is also a fast-evolving area, and natural language processing tools have shown the capacity to identify small-scale, linguistic abnormalities, semantic and communicational impairment, as well as, the communication deficits that occurs before an overt decline in cognitive abilities, in many cases. Speech fluency, vocabulary complexity, sentence structure and acoustic features can be examined using AI systems to determine people who are at a higher risk of having dementia [42]. Moreover, online cognitive evaluation systems have become useful clinical instruments through offering automated, objective and scalable measures of memory, attention, executive functioning and problem-solving skills. The combination of wearable devices, smartphone applications, and remote monitoring technologies have also increased the clinical utility of AI by facilitating the continuous monitoring of patient behavior, mobility, sleep patterns, and daily functioning in real-life settings. These systems produce voluminous longitudinal data which can be processed by the means of machine learning algorithms to detect the initial signs of cognitive decline and track the progression of the disease in the long term [6]. The value of AI in personalized medicine and optimization of treatment has also been proven with recent advances. Predictive models have the potential to forecast the progression of disease, determine who will respond to certain therapeutic interventions, and assist in the personalized care plan depending on genetic, clinical, imaging, and lifestyle data. The use of AI-assisted decision support systems is gradually becoming part of clinical processes to enhance diagnostic reliability, decrease clinician workload, and increase evidence-based treatment selection [43]. Furthermore, AI has also played a crucial role in drug discovery and clinical trial design by discovering new therapeutic targets, streamlining patient recruitment, and forecasting treatment responses. The recent literature released in the period of 2020–2026 has been continuing to present positive results on the application of AI technologies in the diagnosis and treatment of Alzheimer disease, which have led to an increase in both diagnostic and prognostic accuracy and patient-centered care [10].

Table 3 provides a summary of recent studies, AI methods, clinical trials, and key findings in the research on the Alzheimer disease. All these developments are indicative that artificial intelligence is becoming a crucial part of the contemporary research and clinical management of the Alzheimer's disease, with its innovative approaches to early detection, precision medicine, disease monitoring, and long-term patient care, in addition to facilitating the shift to more efficient and personalized neurological care.

Table 3. Recent studies on artificial intelligence in Alzheimer's disease (2020–2026).

Author(s) & year	AI technique	Data source	Objective	Key findings
Wen et al., 2020	Deep Learning (CNN)	MRI Images	Early detection of Alzheimer's disease	Achieved high accuracy in differentiating AD from healthy controls.
Jo et al., 2020	Machine Learning	Neuroimaging Data	Prediction of cognitive decline	Improved prediction of disease progression.
Qiu et al., 2021	Deep Learning	MRI and PET Scans	Automated diagnosis of AD	Enhanced diagnostic sensitivity and specificity.
Spasov et al., 2021	Convolutional Neural Network	MRI Data	Identification of Mild Cognitive Impairment (MCI) conversion	Successfully predicted conversion from MCI to AD.
Gupta et al., 2022	Machine Learning Algorithms	Blood Biomarkers	Biomarker-based diagnosis	Improved non-invasive detection of Alzheimer's disease.
Wang et al., 2022	Natural Language Processing (NLP)	Speech Samples	Early cognitive impairment detection	Detected linguistic changes associated with dementia.
Liu et al., 2023	Deep Neural Networks	Multimodal Data	Disease classification	Increased diagnostic performance through data integration.
Zhang et al., 2024	Explainable AI (XAI)	MRI and Clinical Data	Transparent clinical decision support	Improved interpretability of AI-generated predictions.
Chen et al., 2025	Predictive Analytics	Longitudinal Patient Records	Disease progression forecasting	Enabled personalized prognosis and treatment planning.
Smith et al., 2026	AI-Integrated Precision Medicine Model	Genomic, Biomarker and Clinical Data	Personalized treatment optimization	Improved individualized therapeutic decision-making.

FUTURE PERSPECTIVES AND EMERGING TECHNOLOGIES

The development of artificial intelligence (AI) technologies combined with precision medicine, digital healthcare, and explainable clinical decision-making systems are becoming the future direction of Alzheimer disease research. Despite the impressive displays of performance of the existing AI models in the areas of disease diagnosis, prediction and optimization of treatments, one of the most significant issues preventing widespread clinical use is the black-box quality of most deep learning algorithms where predictions are provided without a clear explanation of how decisions are made [44]. To overcome this shortcoming, Explainable Artificial Intelligence (XAI) has become an increasingly popular area of research that seeks to enhance the level of transparency, interpretability, and clinician confidence in AI-generated results. XAI methods allow health workers to see the logic behind algorithmic predictions, valuable biomarkers, and confirm diagnostic suggestions, making them safer and more reliable to implement in clinical practice [45]. Recent literature has highlighted the need to have explainable models in the classification of Alzheimer disease, risk prediction and treatment planning, especially in high-stakes neurological decision-making context. Moreover, the creation of smart healthcare ecosystems and digital therapeutics is likely to significantly shape the future of the

Alzheimer disease management [9]. Digital therapeutics are based on evidence-based software platforms, mobile apps, virtual cognitive training programs, wearables, and remote monitoring technologies that provide personalized interventions and continuously monitor the health status of a patient. Such technologies facilitate real-time data gathering of cognitive performance, patterns of behavior, quality of sleep, medication adherence, and daily activities, which can enable clinicians to establish minor changes that are associated with the disease and which precede serious clinical worsening [46]. A combination of AI and Internet of Things (IoT) devices, cloud computing, digital biomarkers, and telemedicine platforms have brought about opportunities to deliver health services in a more proactive, accessible, and patient-centered manner (Figure 3).

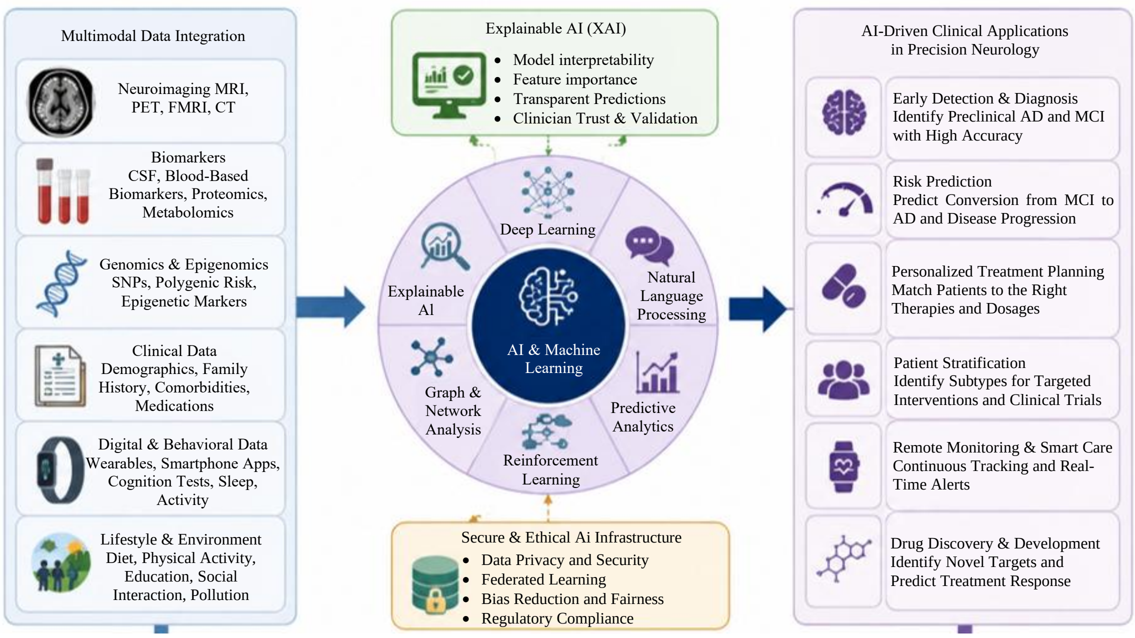

Figure 3. Future integration of artificial intelligence in precision neurology.

Smart healthcare systems can process high amounts of patient data that are constantly being generated, assist in automated clinical decision-making, and provide personalized care planning and decrease healthcare burden and enhance quality of life. The future of precision neurology is anticipated to include integration of multimodal data with genomics, proteomics, metabolomics, neuroimaging, wearables and AI predictive analytics to design very personalized disease management plans. State-of-the-art machine learning systems, graph neural networks, digital twins and adaptive predictive systems can help clinicians predict the progression of individual disease, optimize therapeutic actions and new therapeutic targets with unprecedented precision. Besides [47], AI-based drug discovery systems are likely to increase the rate at which disease-modifying therapies are developed by discovering new molecular pathways and personal responses to treatment. It is expected that the future implementation of artificial intelligence in the field of precision neurology will change the paradigm of Alzheimer disease treatment to be focused on prediction, prevention, and personalized treatment options and, as a result, enhance the quality of diagnostic, treatment, and long-term patient outcomes and advance the overall objectives of precision medicine [48].

CONCLUSION

Artificial intelligence (AI) has become one of the most transformational technologies in the Alzheimer disease field of research and clinical practice, providing novel solutions to most of the long-standing problems related to the early diagnosis, disease monitoring and individualized treatment. With the ever-increasing world burden of Alzheimer disease, there is a pressing need to have more precise, convenient, and patient-focused methods that can provide prompt intervention and better outcomes in the long-term. The combination of AI technologies, such as machine learning, deep learning, natural language processing, and predictive analytics, has considerably increased the capability of analyzing multimodal datasets of complex data that are generated based on neuroimaging, biomarkers, genomics, clinical records, speech patterns, and wearable devices. Such innovations have helped in the earlier identification of disease-related changes, enhanced accuracy in diagnosis, and offered precious information on the development of a disease that was once hard to acquire using the conventional approach. Moreover, AI-driven precision medicine strategies have opened novel prospects of customizing treatment planning by incorporating patient-specific biological, clinical, and environmental data to maximize treatment decision-making. New technologies, like explainable artificial intelligence, digital therapeutics, remote monitoring systems, and smart healthcare platforms, are also increasingly contributing to the role of AI in the management of dementia by enhancing transparency, accessibility, and ongoing patient care. Although these are encouraging developments, there are still several challenges and they include; data quality, privacy protection, bias of the algorithm, interpretability, regulatory approval, and clinical validation. Overcoming these limitations will entail interdisciplinary teams of clinicians, researchers, data scientists, policymakers, and technology developers to make AI-driven healthcare solutions safe and effective. Further progress in neurology precision is projected to enhance even more the combination of artificial intelligence with genomics, neuroimaging, digital biomarkers and patient-centered therapies, leading to the emergence of predictive and preventive healthcare models. To summarize, artificial intelligence is an effective and fast-developed resource that has the potential to transform the initial diagnosis and personalized treatment of Alzheimer disease. Further investigation, technological development and responsible clinical implementation will be necessary to translate these developments into significant changes in patient care, which will eventually lead to improved clinical outcomes, improved quality of life, and more sustainable health care systems among people with Alzheimer disease.

REFERENCES

1. Cipriani G, Danti S, Picchi L, Nuti A, Fiorino MD. Daily functioning and dementia. Dement Neuropsychol. 2020;14(2):93–102.
2. Altuna M, Rodríguez E, Núñez M, Trueba-Saiz Á, Lizan L, Díaz-Cerezo S. A systematic literature review of the epidemiological, diagnostic workup, humanistic, and economic burden of Alzheimer’s disease in Spain. Cureus. 2026;18(1).
3. Kamatham PT, Shukla R, Khatri DK, Vora LK. Pathogenesis, diagnostics, and therapeutics for Alzheimer’s disease: Breaking the memory barrier. Ageing Res Rev. 2024;101:102481.
4. Lv M, Wang Q, Yu G, Chen J, Zhou X, Chen Z, et al. Choroid plexus-glymphatic axis disruption in Alzheimer’s disease: Cerebrospinal fluid expansion as a mediator of metabolic dysfunction and cognitive decline. J Alzheimers Dis. 2026;110(4):1752–1765.
5. Ali SA, Ali S, Shamim S. Role of artificial intelligence in transforming diagnosis, treatment, and patient care: A review. Curr Pharmacogenomics Pers Med. 2026;23(1):E18756921404728.
6. Kale M, Wankhede N, Pawar R, Ballal S, Kumawat R, Goswami M, et al. AI-driven innovations in Alzheimer’s disease: Integrating early diagnosis, personalized treatment, and prognostic modelling. Ageing Res Rev. 2024;101:102497.
7. Singh MS, Thongam K, Choudhary P, Bhagat PK. Stroke risk prediction and prevention: Traditional versus machine learning approaches. Arch Comput Methods Eng. 2026;33(3):3583–3634.
8. Han Y, Kim DH, Pack SP. Nanomaterials in drug delivery: Leveraging artificial intelligence and big data for predictive design. Int J Mol Sci. 2025;26(22):11121.
9. Rajaraman S. Artificial intelligence in neurodegenerative diseases: Opportunities and challenges. In: AI and Neuro-Degenerative Diseases: Insights and Solutions. 2024. p. 133–153.
10. Alyaqoobi HI, Lopez-Guede JM, Dara OA, Ramos-Hernanz JA, Aramendia I, Teso-Fz-Betoño D. Advances in AI-based diagnosis of Alzheimer’s disease using MRI: A comprehensive survey. Front Med (Lausanne). 2026;13:1767090.
11. Shaikh AA, Wilkhoo HS, Pillai A, Thomas S, Singh B, Nair N. Analyzing the therapeutic and preventive potential of probiotics in Alzheimer’s disease: A scoping review. Explor Neuroprotect Ther. 2025;5:1004120.
12. Abdulkhaliq AA, Kim B, Almoghrabi YM, Khan J, Ajoolabady A, Ren J, et al. Amyloid-β and tau in Alzheimer’s disease: Pathogenesis, mechanisms, and interplay. Cell Death Dis. 2026;17(1):21.

13. Chaudhary S, Iyer SM, Narwal S, Mitra M, Tare M. Current perspectives on the genetics of neurodegenerative diseases: A narrative review. Aging Adv. 2026:10–4103.
14. Zhang N, Chai S, Wang J. Assessing and projecting the global impacts of Alzheimer's disease. Front Public Health. 2025;12:1453489.
15. O'Connell SS, Whelton PK, Li F, Allouch F, Shapiro L, Vandenburg M, et al. Global hypertension 2000 to 2020: Trends, disparities, and progress in awareness, treatment, and control. J Am Coll Cardiol. 2026;87(18):2338–2351.
16. Varghese T, Sheelakumari R, James JS, Mathuranath PS. A review of neuroimaging biomarkers of Alzheimer's disease. Neurol Asia. 2013;18(3):239–247.
17. Pei X, Zuo S, Li N, Zhou P, Ma R, Yuan X, et al. Advances in electrochemical and fluorescent microanalytical detection of serum free light chains for early cardiac amyloidosis diagnosis: Emerging technologies and diagnostic implications. Microchem J. 2026;118186.
18. Shir D, Lachner C. Alzheimer's disease: A clinical update on diagnosis and treatment. Neurol Neurochir Pol. 2026;60(2):128–137.
19. Kumar R, Patel S, Mishra PS, Srivastava S, Sridhar SB, Shareef J, et al. From molecular networks to medicines: Targeting complexity in Alzheimer's disease (AD) therapy. Mol Neurobiol. 2026;63(1):621.
20. Thakur RA, Gul S, Hamid S. Artificial intelligence and human thought: A review of cognitive augmentation, challenges, and ethics. Sci Cult. 2026;12(2 Pt 1):1566.
21. Fahim YA, Hasani IW, Kabba S, Ragab WM. Artificial intelligence in healthcare and medicine: Clinical applications, therapeutic advances, and future perspectives. Eur J Med Res. 2025;30(1):848.
22. Anand S, Das P, Bivina GR. Machine learning in household trip generation modelling: A comprehensive review. Arch Comput Methods Eng. 2026:1–31.
23. Omeye EC. Multi-modal data analysis for stroke prediction: Unveiling hidden biomarkers through machine learning. Int J Real Time Appl Comput Syst. 2026;3(1).
24. Mao Y, Wang X. Automatic classification and prognosis prediction of cerebral hemorrhage based on a deep learning model. Front Neurol. 2026;17:1725732.
25. Perera LR, Ganegoda GU. Alzheimer's disease prediction using clinical data approach. In: 2023 8th International Conference on Information Technology Research (ICITR); 2023 Dec 7; IEEE. p. 1–6.
26. Makady A, Debray TPA, Sarri G. Introduction to RWD and RWE for decision-making in healthcare. In: Comparative Effectiveness and Personalized Medicine Research Using Real-World Data. Boca Raton (FL): Chapman and Hall/CRC; 2026. p. 3–11.
27. Swamy A, Agrawal DK. Enhancing early diagnosis: Multimodal AI approaches for neurodegenerative diseases. J Biotechnol Biomed. 2026;9(1):67.
28. Abdullahi MK, Wadood AS, Nabi MS, Mansor SB, Fauzi MF. Advancing nasopharyngeal carcinoma diagnosis: A systematic review of AI-driven machine learning techniques for CT, MRI, and WSI imaging in bioengineering. Radiation. 2026;6(2):16.
29. Dhauria M, Mondal R, Deb S, Shome G, Chowdhury D, Sarkar S, et al. Blood-based biomarkers in Alzheimer's disease: Advancing non-invasive diagnostics and prognostics. Int J Mol Sci. 2024;25(20):10911.
30. Espinoza C, Martella D. Assessment of language impairments towards identifying markers for early diagnosis of pathological cognitive decline. Behav Sci. 2026;16(3):345.
31. Wang M, Peng F, Mu W, Tao Y, Zhao H, Yin Q, et al. Prospective observational study on behavioral monitoring, disease progression assessment, and screening model development for patients with depression using wearable devices and mobile phones: Protocol. Front Psychiatry. 2026;17:1637109.
32. Villa C. Biomarkers for Alzheimer's disease: Where do we stand and where are we going. J Pers Med. 2020;10(4):238.
33. Leopold JA, Loscalzo J. Emerging role of precision medicine in cardiovascular disease. Circ Res. 2018;122(9):1302–1315.
34. Ahire SM, Pawar PS, Sonawane VN, Jadhav SP. Personalized medicine and pharmacogenomics: Impact of genetic variation on drug response and individualized therapy—A review. Asian J Pharm Technol. 2026;16(1):91–98.

35. Paul-Chima UO. Pharmacogenomics and toxicogenomics in personalized public health: Integrating genetic insights, emerging technologies, and global regulatory perspectives to prevent drug-induced toxicity and enhance therapeutic outcomes. Curr Pharmacogenomics Pers Med. 2026;23(1):E18756921410152.
36. Cheruvu R. Resilient AI for healthcare IoT: Addressing failure modes and safety challenges. In: Advances in Image Processing, Reliability, and Artificial Intelligence. Amsterdam: Elsevier; 2026. p. 1–17.
37. Karunanayake N. Next-generation agentic AI for transforming healthcare. Inform Health. 2025;2(2):73–83.
38. Chhabra C, Saroha R, Kosvi M, Singh S, Gautam VS, Kumari P. Artificial intelligence in clinical physiology: System-wise applications in diagnostics, monitoring, and medical education. J Family Med Prim Care. 2026;15(3):1115.
39. Dainis AM, Ashley EA. Cardiovascular precision medicine in the genomics era. JACC Basic Transl Sci. 2018;3(2):313–326.
40. Xu Q, Lu J, Zhang Z, Xu D, Guo C. Deep learning-based cognitive impairment brain imaging analysis: New methods, new technologies, and new paradigms. Neural Regen Res. 2026;21(9):4135–4147.
41. Hussain MS, Ramalingam PS, Chellasamy G, Yun K, Bisht AS, Gupta G. Harnessing artificial intelligence for precision diagnosis and treatment of triple negative breast cancer. Clin Breast Cancer. 2025;25(5):406–421.
42. He R, Chapin K, Al-Tamimi J, Bel N, Marquié M, Rosende-Roca M, et al. Automated classification of cognitive decline and probable Alzheimer’s dementia across multiple speech and language domains. Am J Speech Lang Pathol. 2023;32(5):2075–2086.
43. Setyorini D, Ambarwati R, Minarti M, Hasanah N. AI-assisted diagnostics in nursing practice: Impact on patient assessment and care. J World Future Med Health Nurs. 2026;4(1):1–3.
44. Pathak P, Mujumdar S, Pillai S. Unveiling the black box: Case studies of XAI in real-world healthcare systems. In: Attacks and Defenses in Explainable Artificial Intelligence. 2026. p. 283–316.
45. Egbunu AS, Okedoye AM. Harnessing artificial intelligence for early disease detection: Opportunities and challenges in modern healthcare. J Comput Theor Appl. 2026;3(3):384–401.
46. Ferrara F, De Berardinis F. The use of digital therapeutics in the management of chronic diseases: State of the art, evidence and prospects. SN Compr Clin Med. 2026;8(1):148.
47. Elfatimi E, Lekbach Y, Prakash S, BenMohamed L. Artificial intelligence and machine learning in the development of vaccines and immunotherapeutics—Yesterday, today, and tomorrow. Front Artif Intell. 2025;8:1620572.
48. Kim M, Kwon H, Sohn S, Lee WJ, Cho K, Kim GW. Alzheimer’s disease diagnosis and treatment: From pathophysiological insights to therapeutic advances in the era of precision neurology (2025 review). J Alzheimers Dis. 2026;109(1):17–33.

