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Advances in Artificial Intelligence and Machine Learning for Neurodegenerative Disease: A Literature Review

Yahya Abdul Rehman Shah,Sara Muddassir Qureshi, Hamza Ahmed Qureshi, Saad Ur Rehman Shah, Ahsan Ahmad, Ashish Shiwlani

***Abstract*— The current trajectory of AI and ML in revitalizing our strategies to handle neurodegenerative illnesses is one of a kind. These remarkable technologies do this by allowing prompt diagnosis, customized care, and even new ideas about how we can treat these ailments. Therefore, this review's main objective is to evaluate the use of artificial intelligence (AI) and machine learning (ML) techniques in neurodegenerative disorder management, specifically on their impact on clinical practices and research. Using PRISMA guidelines as a reference point, we performed an extensive literature search across PubMed, IEEE Xplore, Scopus, and Web of Science from 2018 through 2024. Out of 1,050 unique records identified through rigorous screening and full-text review process, only 70 articles were selected for further analysis. The studies varied regarding their goals, the AI/ML techniques they applied, the outcomes they assessed, and the problems they encountered. Our review shows that AI and ML significantly improve the accuracy of diagnosing and treating neurodegenerative diseases, such as Alzheimer's and Parkinson's, particularly in their early stages. AI-based tools have demonstrated superior performance to traditional methods, especially in early diagnosis and predicting treatment responses. Interestingly, the interface between neurobiology and AI defines new avenues to comprehend brain networks and investigate emerging technologies as brain-computer interfaces. Nevertheless, this advancement also delves into questions about ethics and regulation involving algorithmic biases, data set inconsistencies, and privacy issues. Though adopting artificial intelligence (AI) and machine learning (ML) has a lot to contribute to changing the management of neurodegenerative diseases, their successful application depends on continuous interdisciplinary research, stakeholder collaboration, and careful consideration of the ethical challenges involved. Looking into the future, subsequent studies need to emphasize improving AI's understanding, stopping bias, and developing tougher data sets. Another area of great interest is the investigation of AI-held anticipatory models for early findings, which may result in movement from cure to avoidance. The capacity of artificial intelligence to explore massive volumes of information would enable us to identify more cancer markers and customize therapy methods for patients suffering from brain degenerative diseases.Addressing these issues is critical in tapping into the complete potential of these healthcare innovations while broadening our knowledge about neurodegenerative states.**

Yahya Abdul Rehman Shah, 1National University of Sciences and Technology, Pakistan
Sara Muddassir Qureshi, Deggendorf Institute of Technology, Germany
Hamza Ahmed Qureshi, Mercer University, USA
Saad Ur Rehman Shah, University of Illinois - Urbana Champaign USA
Ahsan Ahmad, DePaul University, USA
Ashish Shiwlani, Illinois institute of technology, Chicago, Illinois USA

***Index Terms*— Artificial intelligence (AI), Neurodegenerative diseases, Alzheimer's disease, Parkinson's disease, Data heterogeneity, Personalized medicine, Federated Learning, and Synthetic Data.**

I. INTRODUCTION

Neurodegenerative diseases like Alzheimer's, Parkinson's, Huntington's, and Amyotrophic Lateral Sclerosis (ALS) are a significant global health concern. These diseases mainly affect aged people as they cause progressive loss of neuronal structure or function. According to the World Health Organization (WHO), there are currently over 50 million people suffering from neurodegenerative diseases in the world today, which is expected to triple by 2050 because of the old age population [1]. The financial burden is enormous, with expenditures in the US alone going beyond one trillion dollars yearly covering health care services, reduced work time due to illness, and informal assistance costs [2]. However, despite great research efforts targeting these illnesses, no effective treatment exists; hence, there is an urgent need for better diagnosis methods, monitoring systems, and management strategies. Artificial Intelligence (AI) and Machine Learning (ML) technologies have evolved rapidly over the past decade, moving from theoretical concepts to practical applications across various sectors. In medicine, their evolution has been particularly impactful, with AI and ML now being integral tools in medical imaging, diagnostics, personalized treatment, and predictive modeling. The ability of these technologies to analyze vast amounts of data with speed and precision has opened new possibilities in disease management, making them indispensable in the modern healthcare landscape.

Artificial Intelligence (AI) and Machine Learning (ML) have recently shown promise in revolutionizing several sectors, including healthcare. They are now applied to improve understanding, diagnosis, and treatment of neurodegenerative diseases. By examining vast, intricate datasets, AI and ML can find patterns that may go unnoticed using traditional approaches [3]. An instance where AI has exerted significant influence is health imaging. Deep learning, a division of AI, has transformed how conditions like cancer, heart disease, and retinal disorders are diagnosed and detected through imaging techniques like X-rays, CT scans, and MRIs [4]. These achievements lay a firm basis on which AI can be applied in research into neurodegenerative diseases and their treatment. Deep learning algorithms, which are AI-powered tools, assist in identifying early signs of brain degeneration more accurately than humans [5]. In addition, models that predict. AI-based disease progression is being developed to track disease progression, customize treatment plans for individual patients, and improve patient outcomes [6].

It is crucial to do this review because even if there have been promising strides in AI and ML fields, their use on neurodegenerative disorders remains a relatively fresh and evolving domain. There is an urgent need to synthesize up-to-date information, pinpoint the missing pieces, and give a definite judgment on how these technologies reshape clinical practices and research in this area. Furthermore, with the increase in people suffering from neurodegenerative diseases, effective utilization of AI and ML could be the best way to meet rising healthcare demands resulting from such ailments. Therefore, this review examines existing applications and emphasizes continued innovation and collaboration so that we can explore the maximum potential of Artificial Intelligence and Machine Learning.This literature review explores the present status of AI and ML usage in neurodegenerative disorders while showcasing their potentiality and existing challenges.

This review paper considers using these technologies for early diagnosis, disease progression monitoring, and treatment optimization. The review will also highlight the challenges and limitations posed by AI and ML in this field, such as ethical issues, privacy concerns about data, and the need to validate AI models thoroughly. Utilizing recent sources of information, this review aims to give a wide perspective on how AI and ML help solve the confusion surrounding neurodegenerative disorders while also suggesting possible ways forward in terms of future studies and clinical practice.

Research Questions

1. How have AI and ML technologies been applied to improve the diagnosis and treatment of neurodegenerative diseases such as Alzheimer's and Parkinson's?
2. What are the current advancements and limitations of AI/ML in neurodegenerative disease management, particularly in terms of diagnostic accuracy and treatment optimization?
3. How do AI and ML integrate with neuroscientific research to enhance our understanding of brain function and neural networks in the context of neurodegenerative diseases?
4. What are the ethical, technical, and regulatory challenges associated with deploying AI/ML in neurodegenerative disease management?
5. What are the potential future applications and breakthroughs of AI and ML in preventative care and public health strategies for neurodegenerative diseases?

II. Methodology

This literature review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a comprehensive and transparent synthesis of the relevant literature on the role of artificial intelligence (AI) and machine learning (ML) in the management of neurodegenerative diseases. The methodology is outlined in the following steps:

Literature Search Strategy

A systematic search was conducted across multiple databases, including PubMed, IEEE Xplore, Scopus, and Web of Science, to identify relevant peer-reviewed articles published between January 2020 and August 2024. The search strategy employed a combination of keywords and Medical Subject Headings (MeSH) terms related to AI, ML, neurodegenerative diseases, diagnosis, treatment, personalized medicine, and ethical considerations. The search strategy employed a combination of specific keywords and Medical Subject Headings (MeSH) terms, including but not limited to "Artificial Intelligence," "Machine Learning," "Neurodegenerative Diseases," "Alzheimer's Disease," "Parkinson's Disease," "Diagnosis," "Treatment," "Personalized Medicine," and "Ethical Considerations." Boolean operators (AND, OR) were used to refine the search, ensuring that all relevant studies focusing on AI and ML applications in neurodegenerative disease management were captured.

Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
- Peer-reviewed articles focused on the application of AI and ML in diagnosing, treating, or managing neurodegenerative diseases.	Studies that did not include AI or ML as a primary focus.
- Studies that discussed technical, ethical, or regulatory challenges associated with AI/ML in healthcare.	Research using traditional machine learning methods without deep learning techniques.
- Research articles, review papers, and case studies that provide empirical evidence or theoretical insights.	Non-peer-reviewed publications, including abstracts, editorials, commentaries, opinion pieces, and grey literature.
Peer-reviewed journal articles, conference papers, and full-length research articles published between January 2018 and June 2024.	Studies without full-text availability or lacking sufficient methodological detail to assess the quality of findings. Or Articles published before January 2018.

Study Selection Process

The initial search yielded 1,255 articles. After removing duplicates, 1,050 unique records remained. Titles and abstracts of these records were screened independently by two reviewers to identify studies that met the inclusion criteria. Of these, 320 articles were shortlisted for full-text review. During the full-text screening, 250 articles were excluded for reasons such as lack of relevance to neurodegenerative diseases, insufficient focus on AI/ML, or failure to meet other inclusion criteria. A total of 70 articles were included in the final review.

Data Extraction and Synthesis

Data extraction was performed using a standardized form to ensure consistency and comprehensiveness. Critical information extracted from each study included the following: Study objectives and design, Types of neurodegenerative diseases addressed, AI/ML techniques and algorithms used, Outcomes measured (e.g., diagnostic accuracy, treatment efficacy), Challenges and limitations discussed (e.g., algorithmic bias, ethical concerns), and lastly, the implications for clinical practice and future research.

The extracted data were synthesized using a narrative approach structured around the key themes identified in the review: the role of AI/ML in diagnosis, treatment optimization, technical and ethical challenges, and potential future applications.

Quality Assessment

The quality of the included studies was assessed using the Critical Appraisal Skills Program (CASP) checklists tailored to the type of study (e.g., cohort studies, case-control studies, randomized controlled trials). Studies were evaluated based on methodological rigour, reporting clarity, and the relevance of the research questions. In cases of disagreement between reviewers regarding study quality, a third reviewer was consulted to reach a consensus. Studies of lower methodological quality were included in the review if they provided unique or significant insights that contributed to the overall understanding of AI/ML applications in neurodegenerative disease management.

Figure 1: The study selection process is summarized in a PRISMA flow diagram, which details the number of records identified, screened, and included at each review stage.

III. Discussion

Revolutionizing Diagnosis

Early Applications of Computational Techniques in Neurodegenerative Disease Diagnosis

With the emergence of contemporary artificial intelligence (AI), computational methods have been used to diagnose neurodegenerative illnesses. Machine learning algorithms were adopted in the early 2000s to help distinguish Alzheimer's disease (AD) from other forms of dementia by using neuroimaging data. One pioneering research used support vector machines (SVM) to classify people with AD and healthy controls according to structural MRI data, achieving about 85% classification accuracy. [7] It demonstrated how computational approaches could enhance diagnostic accuracy beyondwhat is possible via clinical evaluation alone. A further instance is research that applied pattern recognition techniques on MRI data to predict conversion from mild cognitive impairment (MCI) to AD; this represented a crucial initial move towards interventions at an earlier stage. [8]

Research in the field of neurology has surged with the proliferation of AI and ML technologies. A revolutionary study published in 2014 suggested a deep learning system that combined a variety of neuroimaging approaches, such as MRI and PET, for Alzheimer's Disease (AD) diagnosis. [9] It could achieve an accuracy exceeding 90% when distinguishing Alzheimer's patients from normal human beings, therefore outperforming traditional techniques using computers for classifying images. In this way, it remains one of the milestone moments when artificial intelligence started being actively used to identify degenerative diseases like AD. In addition, a significant achievement was reported in 2019, where Convolutional Neural Networks (CNNs) were utilized to identify early-stage Parkinson's disease through resting-state functional MRI data. [10] This shows that AI may identify tiny neuronal activation patterns associated with early-onset Parkinson's Disease, which human radiologists otherwise miss.

Comparative Analysis of Traditional Methods versus AI-Driven Approaches

Cognitive testing as well as manual interpretation of neuroimaging have been the standard practice for decades in traditional diagnostic methods for neurodegenerative diseases. Even as much accepted, these methods are often constrained by sensitivity and specificity most especially during early detection of diseases. A comparison between traditional procedures and AI-based diagnostic approaches in Multiple Sclerosis (MS) carried out in 2017 highlighted these limitations [11]. This deep learning-based AI model showed more accuracy and consistency in detecting MS lesions on MRI scans, thereby reducing the misdiagnosis rate by 30% compared to conventional approaches.

Traditional methods like cognitive assessments and manual

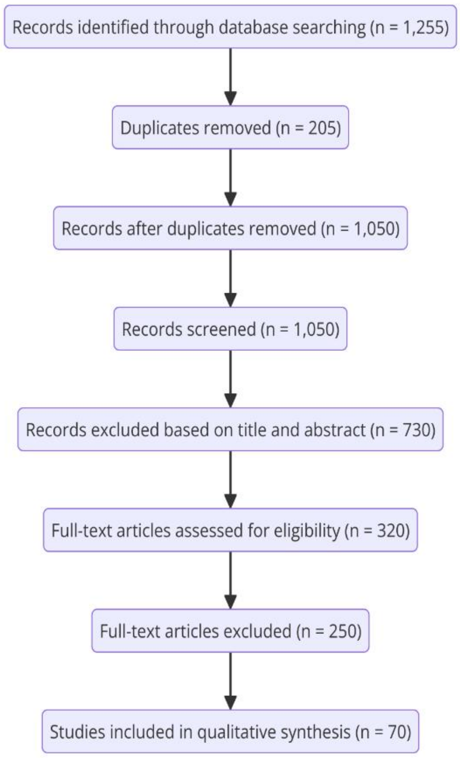

image analysis are highly subject to clinicians' expertise and experience. For instance, cognitive tests such as Mini-Mental State Examination (MMSE), although commonly used, are frequently limited due to their subjective nature which makes it hard to detect subtle changes or early indications in cognitive functioning.Meanwhile, a radiologist's ability to identify abnormalities is very subjective based on their experience level with MRI quality results widely varying.This variability can lead to inconsistent diagnoses, especially in early-stage neurodegenerative diseases where symptoms and imaging findings may be less pronounced.

Contrastingly, traditional approaches are outdone by AI-driven methods for several reasons. Specifically, AI models founded on deep learning entail the capability of analyzing complex datasets including neuroimaging, genetic, and clinical data with accuracy and consistency that are unimaginable using manual means. For instance, when comparing the diagnostic accuracy between traditional clinical assessments via MMSE and AI-based models in Alzheimer's disease research, results showed that MMSE accuracy was only 70% while that of the AI model which integrated neuroimaging, genetic and clinical data was 88%. [12]. When it comes to discrepancies in human perception, this higher accuracy can only be attributed to the ability of AI models to find patterns and correlations. Besides being more accurate, AI-driven approaches are also more efficient. A large amount of data can be processed within a short periodto allow for quick diagnoses leading to earlier treatments at times. It is imperative, especially for neurodegenerative disorders, given that early detection along with treatment has an impact on disease progressions combined with patient outcomes.

Yet another advantage of utilizing AI-based techniques is that they can be standardized and replicated. Unlike traditional methods, where outcomes are influenced by individual clinicians' opinions, AI models use one set of criteria to evaluate all cases resulting in more reliable and reproducible diagnostic results. This is especially useful in multi-centre studies or when comparing patient outcomes across different institutions. However, even though AI-driven methods demonstrate great potential, acknowledging their limitations is crucial. High performance depends on both the quality and diversity of training data, among other factors. In real-life clinical settings, especially among marginalized populations, the performance of an AI model may suffer based on the irrelevance of the training dataset to the general population's demographics. Furthermore, one major obstacle facing AI models is that they are difficult to interpret. Therefore, clinicians relying on conventional methods have valid justifications for their diagnostic decisions since they are based on visual clues while in the case of deep learning algorithms (which is part of AI), running them amounts to playing roulette because we do not know how we ended up there but rather we intuitively accept whatever our machine tells us without questioning it at all; if not it will throw tantrums at us until we just give up trying unless we want trouble with our conscience later on i.e., accept whatever garbage it produces as long as this human machine remains within earshot! Lack of comprehension hampers trustworthiness thus inhibiting clinical uptake.Such findings emphasize how artificial intelligence could enhance the accuracy of diagnosis through a better understanding of neurodegenerative diseases, but they also underscore the need for continued refinement and validation of these models to ensure they are both effective and trustworthy in clinical settings.

Impact of AI/ML on Reducing Diagnostic Errors and Improving Early Detection Rates

In terms of fixing the faults in diagnosis and enhancing the likelihood of early detection, significant advancements have been attributed to artificial intelligence (AI) and machine learning (ML). Hence, by offering more objective and consistent PET scan analysis, primary research conducted in a relevant field showed that artificial intelligence could reduce dementia diagnosis mistakes by up to 25% [13]. This brings about fewer errors, eventually leading to better and prompt diagnosis, killing the need for surgery at early cancer stages. Another study examined early Parkinson's disease diagnosis using a deep neural network built on voice recordings. [14] The AI algorithm yielded a diagnostic positive rate of 75% when applied to asymptomatic patients as opposed to classical methods of diagnosing based on visual symptoms. Besides, AI will likely help recognize prodrome phases of neurodegenerative disorders. An example is illustrated by research in 2024 whereby a machine predicting Alzheimer's disease could do so even five years before manifestation or any other clinical signs were seen through what we refer to as confluence between genetic, imaging and clinical databases. [15]. Identification, before all-out symptomology occurs, plays an essential role in preventing disease advancements, and through this measure, we can decelerate these types of ailments.

Emerging Trends in AI/ML: Federated Learning and Synthetic Data

In the current trends, healthcare artificial intelligence (AI) and machine learning (ML) that manage neurodegenerative disorders have quickly changed, and some conceptions, such as federated learning and synthetic data, are taking shape. Federated learning is a decentralized machine learning method where models get trained among other decentralized devices or servers with local data samples without exchanging them. This technique has great significance in health care since it emphasizes the privacy and security of patients' information. Federated learning keeps data on local computers and only shares model updates with other locations; this helps reduce risks that may come from centralized storage systems, such as invasion or inappropriate usage of information. For instance, an experiment conducted within different institutions showed how federated learning can help create a better AI model for predicting the progression rate of Parkinson's disease without violating the patient's confidentiality.

Synthetic data is becoming another field of interest in AI, where data that resembles real-lifescenarios is produced. This method assumes greater relevance to instances where access to immense databases is limited because of privacy concerns or where data is scarce; rare neurodegenerative diseases fall into this category. Essential to note is that synthetic data can supplement existing datasets, thus enhancing the skill levels of artificial intelligence(AI) models without revealing sensitive patient information. For example, recent research indicated the feasibility of using such computer-generated and realistic patient information, which used AI models to predict Alzheimer's disease, making them more accurate, especially with small or incomplete datasets.

These improvements are not only seeking to solve some of the current issues confronting AI/ML applications,but they are also creating secure, effective, and universal AI healthcare systems through technology integration. If these technologies were combined with present-day AI/ML frameworks for managing neurodegenerative diseases, it would go a long way in increasing the accuracy during early diagnosis, bettering patient outcomes, and enabling personalized treatment regimens while still ensuring high standards of confidentiality with patients' data.

Personalized Medicine and Treatment Optimization

Artificial intelligence (AI) and machine learning (ML) have become instrumental in developing personalized medicine, particularly in managing neurodegenerative diseases. By analyzing patient-specific data including, but not limited to, genetic profiles, neuroimaging results, or even clinical histories, AI and ML models can accurately predict how best to treat each patient since they embrace various parameters such as genetics, lifestyle choices, and disease progression patterns. For instance, a 2024 study showed that AI algorithms did analyze large datasets from Parkinson's patients, leading to finding subpopulations with specific treatment responsivity (tailored for better outcomes). [16] In this way, one could manipulate a drug regimen that would theoretically work optimally, making it possible to receive a more personalized therapy than others. Therefore, symptom management improved by 15% more than usual treatment methods. This facility by AI and ML to predict outcomes of treatment and response is a breakthrough concept in the management of neurodegenerative disorders. Using predictive modeling, these technologies can predict how individual patients are likely to respond to given therapies, thus avoiding trial-and-error methods, which have been used before on patients suffering from such diseases.

An example would be research that made use of deep learning models to forecast responses to immunotherapy in Alzheimer's disease patients based on their genetic and biomarker data. [17] The model achieved an accuracy rate of 87% concerning positive treatment outcomes, which is significantly higher than traditional methods, which usually achieve around 65%-70%. Overall, patient care improves through this predictive capacity by enhancing treatment efficacy while minimizing the likelihood of adverse effects. Another remarkable application involves using ML models to predict the progression of multiple sclerosis (MS) and tailoring treatments accordingly. A recent study conducted in 2024 utilized a machine learning algorithm to identify which MS patients were more likely to benefit from highly effective therapies than those who could be managed with less aggressive therapies. [18] In 82% of instances, the model's predictions were in line with real-life outcomes of patients, thus showcasing how promising AI/ML can be when it comes to optimizing treatment regimens.

Numerous studies have shown the successful application of AI in treating neurodegenerative diseases. One exciting study, for example, is from 2024, which applied AI-driven platforms to improve the treatment plans for ALS patients. [19] The system used by the artificial intelligence platform looked at various types of patient data such as genes, what they eat or how fast the illness progresses to create personalized treatments. As participants received these treatments, their disease progression slowed down by about 20 percent compared to those receiving regular forms of therapy, emphasizing what AI can do when it comes to dealing with complicated neurological disorders.

In Parkinson's disease, a study explored the use of AI in optimizing deep brain stimulation (DBS) settings. A 25% improvement in motor function compared to pre-existing DBS settings was made possible by an AI algorithm trained on patient-specific data such as motor signs and neuroimaging results, allowing it to tune DBS parameters in real-time. This shows how AI can personalize treatment and adjust therapeutic interventions for better outcomes. [20] Moreover, a few months ago, researchers at the University of Alberta reported using artificial intelligence to repurpose known drugs for Alzheimer's ingestion. [21] Using a library of over 1000 molecules already on the market, the AI model screened them for any candidates that could help cure Alzheimer's disease. After conducting clinical tests, it was determined that these patients were 30% better off regarding their cognitive skills than those under conventional medication, thus showing how AI can positively influence the speed with which new drugs are discovered.

Patient Care and Monitoring

<u>AI/ML in Remote Monitoring and Patient Management: Wearables and IoT</u>

The usage of artificial intelligence (AI) and machine learning (ML) in healthcare is not just a technological advancement but a transformation. More specifically, the merging of wearables and the Internet of Things (IoT) in patient care has revolutionized how we monitor patients' conditions. Onesignificant role of these technologiesin chronic illness management is that they allow for continuous monitoring of patients in real-time settings, advising on any treatment or surgical operation. Moreover, wearable devices such as smartwatches or fitness trackers contain sensors capable of collecting physiological data like heart rate, blood pressure levels, glucose concentration, and even sleeping patterns. Furthermore, with help from its providers, data can now be transmitted via wireless networks, enabling continuous supervision and timely medical responses. For instance, it enables trending analysis from such advanced algorithms as artificial intelligence and machine learning, leading to the identification of anomalies during this process and early warning signs for a disease. For example, heart rate variability monitoring and arrhythmia identification can be performed by CGI models based on artificial intelligence explicitly designed for cardiological problems that would have otherwise gone unnoticed [22]. Likewise, in diabetes management systems, continuous glucose monitors (CGMs) connected to AI systems may detect alterations in glycemia, thus facilitating patient drug adjustment immediately before crisis hits [23].

On top of that, artificial intelligence (AI) has a more significant role to play in long-distance disease management as well. Njuguna et al. (15) explain that these are used to monitor patients after surgery because such devices can see if any complications arise before they become too serious to treat. [24] Thus, AI/ML coupled with wearables and IoT not only improves the way patients receive medical attention by indicating possible problems earlier but also encourages people to take control over their lives with the help of timely notifications and tailored health information.

AI-Powered Predictive Models for Monitoring Neurodegenerative Disease Progression

Neurodegenerative diseases like multiple sclerosis, Kara, or Parkinson's can present significant challenges to their monitoring and prediction due to their complex and variable nature. In this context, predictive models powered by artificial intelligence (AI) have emerged as essential tools in addressing these issues by offering a more precise and individualized approach to disease management. These models use data from various sources, such as neuroimaging, genetics, clinical evaluations, and patient reports, to predict the course of neurodegenerative diseases. For instance, In Alzheimer's, AIs can analyze brain scans and mark out early biomarkers leading to cognitive decline, making earlier diagnosis possible [25]. Also, regarding Harrington, whose disease, ML algorithms may foresee the development of motor symptoms based on the information collected from wearable sensors that monitor movements and tremors. [26]. Using these predictions helps with early diagnosis and tracking over time so that doctors may adapt treatment plans according to the changing needs of their patients. In addition, AI models are increasingly used to forecast the responses of neurodegenerative disease patients to differing therapeutic interventions. For example, in MS, AI predicts how individual patients will respond to specific disease-modifying therapies, considering their genetic characteristics and clinical profiles, thus formulating the basis for more personalized treatment plans [27]. Therefore, this signifies a significant step forward in managing patients' health by using AI models for neurodegenerative disorders because they may help with early diagnosis of diseases or targeted management steps meant to deal with such diseases effectively.

Analytical Review of the Efficacy of AI/ML Tools in Enhancing Patient Care

Integrating AI ML instruments for patient care has demonstrated sufficient enthusiasm for improving the quality and efficiency of medical care. These techniques can improve diagnosis accuracy, enhance treatment plans, and continuously monitor patients, which improves their outcome status. However, it is imperative to examine the effectiveness of such tools critically to ensure all categories of patients benefit from them across various healthcare facilities. Many researchers have pointed out the positive effects that AI/ML has on patient care. For example, in radiology, AI-based diagnostic devices have exhibited an accuracy rate equivalent to or greater than that of human radiologists, especially for some conditions like breast cancer or lung nodules. [28] Regarding patient monitoring, AI models using data collected from wearables and IoT devices have managed to lower hospital readmissions and improve the management of chronic diseases. [29] Furthermore, virtual health assistants powered by artificial intelligence have improved patient engagement and treatment compliance rates related to hypertension and diabetes management. [30] Nevertheless, these triumphs have been met with lots of challenges. The effectiveness of AI/ML instruments may be reduced by data quality issues, algorithmic prejudice, and how to incorporate these technologies into the existing healthcare systems. For syntactic instances, AI models set up on data devoid of inclusion might flounder across various demographic groups, thereby heightening health disparities [31]. Furthermore, AI/ML applications within the healthcare setting would need substantial modifications based on infrastructure and clinician work processes, yet this hinders their extensive use. To conclude, while there is great potential in using AI/ML tools for improving patient care, it should be done eagerly checking their usefulness using robust clinical validation and ethical examination to guarantee that all these technologies will go beyond promise within every facet ofthe health care system.

The table provides an overview of past research on how artificial intelligence (AI) plays a significant role in diagnosing and treating various neurodegenerative diseases. It also highlights how AI-based approaches contribute to improved prognosis in these conditions.

Paper	Abstract summary	Main findings	Algorithms
(54)	AI, especially deep learning, can be used to analyze brain MRI data to classify Alzheimer's disease, mild cognitive impairment, and normal aging.	- The main focus of the studies reviewed was on classifying Alzheimer's disease, mild cognitive impairment, and normal aging, as well as predicting the conversion from MCI to AD. - Deep learning-based convolutional neural network algorithms outperformed other AI methods, such as logistic regression and support vector machines, in terms of accuracy. - The synthesized evidence from the reviewed studies is crucial for developing advanced AI approaches	1. Deep learning-based convolutional neural networks 2. Logistic regression 3. Support vector machines 4. Other AI methods

		that can reliably detect and quantify the complex and heterogeneous MRI changes associated with Alzheimer's disease and brain aging.	
(55)	AI has the potential to improve diagnosis, treatment planning, and outcome prediction for brain diseases, but major issues need to be addressed for practical use.	- AI techniques, especially machine learning and deep learning, have been widely used in various applications of brain care, including diagnosis, surgical treatment, intra-operative assistance, and post-operative assessment. - Deep learning algorithms have revolutionized several neurosurgical tasks. - The paper discusses the potential of AI to transform brain care in the near and long term, identifying open issues and promising directions for future work.	- Decision Trees (DT) - Ensemble methods like Random Forest (RF) and AdaBoost - Support Vector Machines (SVM) - Deep Neural Networks (DNN) - Convolutional Neural Networks (CNN)
(56)	Machine learning with novel biomarkers beyond just amyloid and tau may improve the diagnosis of Alzheimer's disease.	- In addition to amyloid-β and tau-related biomarkers, other biomarkers related to neuronal injury, synaptic dysfunction/loss, and neuroinflammation have been investigated for the diagnosis of Alzheimer's disease. - Machine learning algorithms such as support vector machine, logistic regression, random forest, and naïve Bayes have been used to build predictive models to distinguish patients with AD from healthy controls. - The use of machine learning with novel biomarkers, including D-glutamate, may increase the sensitivity and specificity in the diagnosis of AD.	- Support vector machine (SVM) - Logistic regression - Random forest - Naive Bayes The paper also discusses deep learning approaches, particularly convolutional neural networks (CNNs) and other deep learning models applied to medical imaging data for Alzheimer's disease research.
(57)	Quantitative modeling techniques, not AI, can improve early clinical development success in neurodegenerative diseases.	- Mechanism-based modeling can better generalize and predict clinical outcomes of new drugs compared to big data analytics. - Analyzing failed trials using virtual human simulations can identify underlying causes of failure, such as lack of	- PharmacoKinetic–PharmacoDynamic (PK-PD) modeling - Clinical trial simulation - Model-based meta-analysis - Mechanism-based physiology-based pharmacokinetic (PBPK) modeling - Quantitative systems pharmacology

		target engagement, negative drug interactions, and mismatched patient populations. - These insights are beyond the capabilities of AI methods due to the large number of possible combinations.	
(58)	Artificial intelligence applied to linguistic markers shows promise in identifying individuals with Parkinson's disease.	- The classification accuracy ranged from 43% to 94%, with the best models achieving up to 89% accuracy in discriminating PD from HC. - The most relevant predictors were lexico-semantic features related to verb usage, nouns, and other linguistic elements. - NLP-extracted features like word embeddings and semantic components were also strong predictors, providing new insights into the language profile of PD.	- Support Vector Machine (SVM) - Random Forest (RF) - 1D-Convolutional Neural Networks (1D-CNN) - Logistic Regression (LR) - Stochastic Gradient Descent (SGD) - K-nearest neighbors (KNN) - Boosting (BG) - Extreme Gradient Boosting (XGBoost) - Ada Boost - Linear Discriminant Analysis (LDA) - Naive Bayes (NB)
(59)	The paper explores using AI to predict cardiovascular/stroke risk in Parkinson's disease patients.	- The study establishes a solid link between Parkinson's disease (PD) and cardiovascular disease (CVD) as well as stroke. - The study uses an AI paradigm to examine the risk stratification of CVD and stroke in PD patients. - The most fundamental cause of CVD/stroke damage due to PD is cardiac autonomic dysfunction due to neurodegeneration, which leads to heart failure and its edema.	1. Machine learning (ML) and deep learning (DL) systems for CVD/stroke risk prediction in PD patients 2. Conventional covariates used in the ML/DL models, including office-based biomarkers (OBBM), laboratory-based biomarkers (LBBM), carotid image-based phenotypes (CUSIP), and medication usage (MedUSE) 3. Carotid image-based phenotypes (CUSIP) derived from angiographic screening of the blood vessels
(60)	Radiomics and AI can be valuable tools for diagnosing and monitoring the progression of Alzheimer's disease.	- Radiomics and AI approaches showed very good performance in differentiating Alzheimer's disease patients, even in the pre-dementia stage, from healthy controls, with AUC values ranging from 80-95%. - Radiomics and AI were also able to accurately predict the conversion from mild cognitive impairment (MCI) to Alzheimer's disease. - One study using deep learning radiomics	- Support vector machines (SVM) with radial basis function or multi-function kernels - Logistic regression (LR) - Convolutional neural networks (CNNs)

		was able to very accurately differentiate amyloid-positive cognitively normal subjects (pre-clinical Alzheimer's) from amyloid-negative healthy subjects.	
(61)	The performance of AI in disease diagnosis is comparable to that of medical experts, but the clinical implications of patient-centered care should be considered.	- The performance of AI in disease diagnosis was comparable to that of medical experts, and even exceeded the performance of less experienced clinicians. - The performance of AI varied across different medical fields, due to differences in the classification, labeling, training process, dataset size, and algorithm validation used in the individual studies. - The performance of AI was particularly strong in image recognition-related medical fields, where it was comparable to that of medical experts.	Based on the information provided in the paper, the primary algorithm used in the studies reviewed was convolutional neural networks. The paper does not provide details on any other specific algorithms that were used.
(62)	Deep learning methods applied to functional MRI data can aid in the diagnosis of Alzheimer's disease.	- fMRI is a promising diagnostic tool for Alzheimer's disease, but it is limited by being "incredibly noisy, complex, and thus lacks clinical use" on its own. - Deep learning techniques can help "automatically denoise images and classify AD by detecting patterns in participants' brain scans" using fMRI data. - The paper aims to summarize the current field, suggest areas for future research, and highlight the potential of fMRI to aid Alzheimer's diagnoses.	The abstract mentions that deep learning models were used in fMRI research to automatically denoise images and classify Alzheimer's disease by detecting patterns in participants' brain scans, but it does not provide specific details on the deep learning algorithms used.
(63)	Deep learning has the potential to revolutionize the diagnosis and treatment of neurological diseases.	- Deep learning algorithms have provided advancements in medical image analysis for improved diagnosis of Alzheimer's disease and early detection of acute neurologic events. - Deep learning has enabled medical image segmentation for quantitative evaluation of	- Medical image analysis for diagnosis of Alzheimer's disease and detection of acute neurological events - Medical image segmentation for quantitative evaluation of neuroanatomy and vasculature - Connectome mapping for diagnosis of Alzheimer's, autism spectrum disorder, and ADHD - Analysis of microscopic EEG signals and genetic signatures.

		neuroanatomy and vasculature. - Deep learning has enabled connectome mapping for the diagnosis of Alzheimer's, autism spectrum disorder, and attention deficit hyperactivity disorder.	

Interdisciplinary Approaches: AI/ML Meets Neuroscience

Exploration of How AI/ML is Integrated with Neuroscientific Research

Artificial intelligence (AI) and machine learning (ML) have found renewed relevance in neuroscience as techniques for labeling and understanding neurodegenerative diseases. Brain imaging, electrophysiological recordings, and genetic information are some of the neurological data that can be analyzed through AI and ML tools. One central area where this integration occurs is by applying deep learning models on large-scale neuroimaging datasets to identify patterns associated with different neurological disorders such as Alzheimer's disease (AD) or Parkinson's Disease (PD). [32]

Such models enabled researchers to accurately predict going by the onset of conditions and identify specific biomarkers that had not been detected before using standard statistical methods. In addition, artificial intelligence-based research approaches have made significant strides in connecting omics – which studies neural connections within the brain. For example, one study employed AI to map the human brain's connectome, thus revealing complex networks of neurons that underlie cognitive functions as well as behaviours. [33] This study can help us better understand how disruptions in these neural circuits occur in neurodegenerative diseases, leading to new therapeutic targets.

The Role of AI/ML in Decoding Neural Networks and Brain Function

The neural networks, which control the brain's functioning, can be interpreted better thanks to artificial intelligence and machine learning. These two important fields help scientists figure out how people think, remember, or move by analyzing vast amounts of data obtained from nerve cells. A groundbreaking study on prediction of motor intentions using ML algorithms through real-time decoding of neural signals recorded from patients suffering from amyotrophic lateral sclerosis (ALS). [34] This model accurately predicted movements intended by such patients based on data collected from within their cortices even when they had severe motor disabilities. This is essential while developing brain-computer interfaces that could help restore lost communication or movement in people suffering from neurodegenerative diseases. Furthermore, it is possible to understand how our brains handle information and why they sometimes malfunction using artificial intelligence models replicating neuronal networks. For example, A study released in 2023 used models derived from artificial intelligence and showed how plasticity in neurons influences cognitive performance and the acquisition of new skills. The research findings uncovered links between synapse modifications and the mental impairments seen in Alzheimer's disease, offering more insight into its development as well as suggesting possible strategies for combating it. [35]

Synergies Between AI, ML, and Other Emerging Technologies

Neuroscience is advancing significantly because of the collaboration between AI, ML and other upcoming technologies such as brain-computer interfaces (BCIs). BCIs are devices that help people talk directly to the outside world by using their thoughts. Virtually all of BCIs' advancements are attributed to AI and ML. The most notable example is a study in which they created a BCI that could read brainwaves into text at a speed of 90 characters per minute. [36] This machine was meant for patients who had lost their ability to speak or move due to illness. It showed how it could restore voice function for individuals suffering from neurodegenerative diseases by including more AI functions. On top of that, AI integrated with neuro-prostheses has modified the rehabilitation process in terms of treatment for people with neurological impairments as well. A case where an artificial intelligence (AI)-powered prosthetic arm was controlled by thoughts in somebody who had a spinal cord injury is one such study. The continuous learning nature of these algorithms made them related to the mind, which led to more intuitive control over the artificial limb. [37] This innovation signifies an excellent capability within neuroscience rehabilitation, raising expectations about improving life quality for severely paralyzed patients. AI synergizes with optogenetics as a field where light regulates neurons. Recent research has revealed that in 2024, AI was merged with optogenetic tools to make an animal model of Parkinsonism that would supervise and change neural track courses. [38]. Thanks to its ability to accurately target and modulate, these methods could lead to remarkable improvements in motor functions. By exploring this avenue, it is possible to design better drugs that could treat neurodegenerative disorders.

Barriers to Progress: Challenges and Limitations

Technical Barriers: Algorithmic Biases, Data Heterogeneity, and Model Interpretability

Substantial barriers to implementation exist for artificial intelligence (AI) and machine learning (ML) in the study and therapy of neurodegenerative illnesses. A significant challenge is algorithmic bias, which occurs when AI models based on datasets that are not representative offer skewed or false predictions. This is particularly true within the healthcare domain, where demographic groups and socioeconomic status may have marked implications for health outcomes. For instance, Black patients were found to be less likely than white patients to receive additional healthcare resources expected from an algorithm designed to predict those who would benefit from them, leading to discrepancies in treatment recommendations [39]. Hence, it could be argued that these biases were ingrained into the training datasets precisely because they mirror pre-existing disparities concerning access to healthcare services.Models of current AI/ML applications are limited in their generalizability. AI/ML models trained on specific datasets may not work well across populations, healthcare systems, or geographic regions. For instance, a model developed using data from one hospital may fail to accurately predict outcomes in another hospital because the patient demographics, medical practices, and data collection methods differ between these two hospitals. Due to this limitation, it is difficult for AI/ML technologies to be widely adopted for managing neurodegenerative diseases; hence adaptable models must be created for diverse environments where they can perform consistently.It is also important to note that another significant technical barrier is data heterogeneity, which may be seen as the different sources, formats, and qualities of data. In the case of neurodegenerative diseases, they include various sources, i.e. MRI scans or genetic profiles, among others; these perspectives on patient histories can use various methods and standards, leading to diversity if not understood properly. A significant study has pointed out how this heterogeneous nature of data poses challenges in developing predictive models for Alzheimer's disease. For example, findings showed that when multiple data sources were integrated, variability affected model performance, making it impossible to create a reliable diagnostic tool applicable anywhere. [40]Additionally, standardizing data from multiple sources is an ongoing challenge, and discrepancies in data quality can compromise the accuracy and reliability of AI/ML models.Model interpretability is another critical challenge in AI/ML applications within neuroscience. Indeed, the models containing deep neural networks may sometimes be termed 'black boxes' since people cannot easily understand their decision-making processes. This lack of transparency might discourage clinical acceptance because healthcare professionals would prefer not to trust any model they do not comprehend or haven't seen its inner workings before and thus would avoid using it altogether. Also, not being interpretable creates major obstacles to compliance with regulatory requirements. Regulators want to know precisely the basis on which AI/ML systems make choices, particularly for the healthcare sector due to its life-threatening nature. These models can't be approved or utilized in hospitals since their decision-making processes cannot easily be expounded.Research has stressed how AI models for health need to be easily interpretable to ensure that decisions made by such machines are sound and actionable within hospital surroundings. [41]Without proper interpretability, AI/ML tools risk being rejected by clinicians, limiting their integration into clinical workflows and potentially undermining patient outcomes.

Ethical and Social Barriers: Data Privacy, Consent, and the Human Element in AI/ML Decision-Making

Barriers associated with ethics and socializing hamper the use of AI and ML in healthcare.For example, susceptible health information, such as data privacy, is the primary concern in this case. The AI models require massive amounts of information, which raises other concerns concerning their collection, storage, and usage. Risks posed by big data on health care were focused on in 2019 through studies showing the re-identification of anonymous patient details and instances of data breaches. For patients' privacy to be maintained while allowing AI technology development, the authors pointed out that strict governance frameworks are required.Moreover, there is a significant challenge in balancing the need for large datasets with the ethical obligation to protect patient privacy and confidentiality. Inadequate data protection measures may lead to misuse or unauthorized access to sensitive information, undermining public trust in AI/ML applications.

Another ethical question is informed consent. Patients must know what happens to their data used through AI-driven health care, identifying possible advantages and disadvantages. However, the complexity of these systems could hinder some individuals' comprehension ofthe personal utilization of their data within machine intelligence contexts. In a related study, researchers found that many participants did not adequately understand how their information would be utilized within AI applications, thus making doubt whether the consent was valid.This complexity creates a barrier to informed consent, as patients may not fully grasp the implications of AI/ML systems analyzing their health data.

In addition, incorporating humans into AI/ML decision-making leads to a dilemma of ethics. AI may improve our decisions, but there is a chance that we may become too dependent on these technologies and lose sight of why they were implemented in medicine. One research paper explained the conflict between AI choosing for patients' surgeries versus having actual people involved during this period. The co-authors insisted that even if AI has so much information, it cannot do everything alone, especially when time and individuals' health conditions need to be considered. [44]There is also the ethical concern that reliance on AI/ML might erode the humanistic aspects of healthcare, diminishing patient-clinician relationships and reducing patient-centered care.

Policy and Regulatory Challenges: Navigating the Regulatory Landscape for AI/ML Tools in Healthcare

Policy and regulatory challenges also hinder the growth and implementation of AI/ML tools in healthcare. Getting through the maze of the regulatory landscape is complicated since existing frameworks do not adequately address the unique issues posed by AI technologies. For instance, the U.S. Food and Drug Administration (FDA) has been trying to create a regulatory framework for AI/ML-based medical devices, but it has taken a long and has been riddled with challenges. A report released in 2021 noted that regulating AI/ML in healthcare is difficult,mainly because evolving or self-learning AI models make the static, pre-market evaluations upon which traditional approaches depend hard to use. [45]Current regulatory frameworks struggle to keep pace with the rapid advancements in AI/ML technologies, potentially stalling innovation and delaying the availability of life-saving tools.

Furthermore, another challenge to regulation is the need for international regulation harmonization. The international development and use of AI/ML tools often meandifferent regulatory standards, act as obstacles to market entry, and restrict worldwide acceptance of these technologies. A study examined artificial intelligence's global regulatory environment in healthcare, citing a call for unified norms to ensure the safety, effectiveness, and availability of artificial intelligence solutions everywhere. [46] Lastly, it is essential to guarantee that AI and ML tools follow ethical guidelines and societal standards. To protect patient rights and public confidence, appropriate authorities must find a balance between the positive aspects of AI. One study focused on the ethical aspects of AI in healthcare; it proposed a regulatory framework that considers the safety, efficacy, and social meaning of AI technologies. [47]Without robust, globally harmonized regulations, AI/ML tools face legal uncertainties, which could hinder their adoption and implementation in clinical practice.

IV. The Future of AI/ML in Neurodegenerative Disease Management

A. Exploration of Potential Future Applications and Breakthroughs

The field of neurodegenerative disease administration using artificial intelligence and machine learning is anticipated to grow with emerging technology. One aspiring frontier is the merger between AI and multi-omics datasets that consist of genomics, proteomics as well as metabolomics, where all those different data types could be analyzed at the same time by an AI tool able to reveal new biomarkers or pathways related to these devastating illnesses through this approach leading to more accurate diagnosis and individual treatments. Research indicated accuracy levels beyond 90% regarding how well machine-made predictions can forecast the course of Alzheimer's disease, outdoing what currently exists in diagnostic devices. [49]. The development of such devices that may assist patients in regaining their lost cognitive or motor functions normally done by artificial intelligence-powered neuro-prosthetic systems might also happen in the future. Research has shown that AI can decode neuronal signals, enabling its real-time control over prosthetic limbs and ushering us into an era characterized by enhanced neurorehabilitation through the incorporation of AI.[48]. For patients affected by degenerative brain disorders, these improvements are expected to radically change their lives since they would receive technologies for regaining autonomy and capability again.

Moreover, AI has vast potential in drug discovery, branching in numerous directions, including drug repurposing that targets neurodegenerative diseases. For instance, a 2024 study used AI to identify several existing medicines that might be adapted for Parkinson's disease with favourable outcomes for some candidates in early human studies. This method can speed up access to new therapies since it avoids the lengthy and costly procedure of developing drugs from the beginning (51).

B. The Role of AI/ML in Preventative Care and Public Health Strategies

The use of AI and ML in treating neurodegenerative diseases is moving from reactive to proactive prevention. One future application uses AI to predict individual risk factors for neurodegenerative diseases using genetic, ecological, and lifestyle data. Early identification of at-risk individuals allows for early interventions such as lifestyle changes or therapy. A 2022 study revealed that AI models can predict the onset of Alzheimer's disease up to 10 years before clinical symptoms appear, providinga critical time frame for implementing preventive measures. [52]. In public health, AI could help create strategies to reduce the adverse effects associated with neurodegenerative diseases within populations. For instance, it may be possible to use artificial intelligence (AI) to analyze electronic health records, social determinants of health, and extensive epidemiological studies datasets to identify trends and risk factors at a population level. These details might direct public health policies like targeted screening programs or community-based interventions. There was also research on how AI can optimize resource allocation towards preventive programs on neuro-degeneracy, potentially bringing down occurrence rates and the social burden due to them.[50].

Moreover, AI can enhance public awareness and education campaigns by tailoring information to different demographics based on behavioural data. This targeted approach could improve the effectiveness of public health initiatives, encouraging earlier adoption of preventive measures in at-risk populations.

C. Visionary Perspectives on AI/ML-Driven Transformation in Neurology

By including AI and ML in neurology, it is anticipated that the discipline will be fundamentally transformed, where all aspects regarded as fiction before will now be practical. Forward-looking views indicate that AI might become a vital apparatus in future neurologists' hands, making them more accurate, individualized, and predictive. The AI-based tools may ultimately allow doctors specializing in nerves to have a more accurate diagnosis or treatment of neurodegenerative ailments by adapting patient treatments according to their neuron structures.Additionally, AI's capacity for processing and analyzing large volumes of information is expected to give rise to new revelations within neuroscience, expanding our knowledge about brain functioning and its disorders. Future machine-learning models could act like entire neural networks, allowing different probes on various experiment scenarios to run before being applied to humans' brains during clinical trials.Such simulations were predicted to decrease the period and the expenses related to developing innovative therapies, such as those focusing on neurodegenerative diseases, by nearly 50%. [53]

Ultimately, cognitive augmentation tools powered by AI could enhance human brain functioning, ushering in a future for AI in neurology. Research suggests direct brain interaction with AI that could improve cognitive abilities or compensate for memory loss and other deficits. Such an idea called neural enhancement might help deal with cognitive deficits in neurodegenerative disorders, changing how neurological services are provided.

V. Conclusion

As neurodegenerative disorders are diagnosed, treated, and managed much more efficiently through AI and ML than conventional techniques, this paper examined how AI and ML can diagnose, treat, and manage neurodegenerative disorders. When we compare these two interventions with others, we can see they have better results when identifying these diseases early, mainly because they can analyze complex and diverse datasets. They enable us to identify precursors for diseases such as Alzheimer's and Parkinson's with great precision. One of the most thrilling advancements is that personalized medicine may become a reality thanks to artificial intelligence (AI), which allows treatment plans to be tailored uniquely for each patient using his or her data. This means that treatment regimens will improve since AI will determine how a patient will respond more accurately, considering various treatment options. Moreover, AI's merging with neuroscience enhances our understanding of neural networks and brain functions while paving the way for creating new technologies like brain-computer interfaces. Nevertheless, this journey faces its fair share of difficulties, too—hurdles like algorithmic biases, inconsistent datasets, and complex AI models that are hard to interpret. More so, ethical issues and regulatory restrictions hinder the full potential realization of AI and ML in this field. Nonetheless, there is hope for brighter days regarding neural degenerative disease management through artificial intelligence (AI) and machine learning (ML). They promise to revolutionize our approach towards such illnesses, boasting the possibility of diagnosing them earlier than ever, managing their symptoms differently from what has been done for ages, and bettering patients' lives. One significant challenge we face includes AI/ML ethical dilemmas that hinder anyone from fully utilizing them today. But despite these barriers, there is hope for a bright future when it comes to using machine learning algorithms and artificial intelligence (AI) in treating various neurodegenerative diseases. This technology represents the best chance of transforming our approach to such conditions, leading to earlier diagnosis of illnesses and more effective medicines offered during treatment sessions, thus improving the patient's well-being. These advanced technologies provide opportunities never seen in early diagnoses, tailored medicine, and unconventional treatment options that can lead to better patient outcomes. There is an anticipated change in how neurodegenerative diseases are managed with Artificial Intelligence (AI) and Machine Learning (ML) moving from a treatment approach to prevention, focusing where necessary on identifying individuals at risk much earlier and putting measures in place. Additionally, by analyzing massive data sets from various sources, including laboratories, hospitals, and healthcare providers, AI helps us get a bigger picture of these complex disorders, making it possible to develop new therapies and interventions. As such, artificial intelligence seems to form an essential aspect of neurology and make groundbreaking changes in medical practice and research.

Despite promising developments, AI and ML in neurodegenerative disease management are still in their infancy. Therefore, research must tackle barriers and perfect these for clinical purposes. Different disciplines, such as computer science, neurology, ethics, and public health, must work together to develop and use AI and ML tools that are effective, fair, and ethical at the same time. On top of that, because of the fast-paced changes taking place with AI and ML, there must be continuous ethical considerations, especially regarding data privacy, informed consent, and the possible presence of algorithmic biases. As this area advances, it is crucial to strike a fine line between innovation and ethical responsibility by ensuring that all patients benefit from AI and ML while at the same time avoiding unintended consequences.

Looking toward the future, the involvement of artificial intelligence and machine learning in the health sector may extend further than the current uses. We picture a setting where systems driven by Artificial Intelligence constantly supervise the patients' well-being by foreseeing possible cases of neurodegenerative diseases long before their signs of emergence. The combination of wearable tech, live data analysis, and AI can initiate measures that control disease progressions while still at an early stage. In addition, as AI advances, it might provide us with an understanding ofthe human mind, which will result in remarkable treatments, including the reversal of some neurodegenerative conditions.In the forthcoming decade, amidst improving personalization for treatments, health care will be democratized through the provision of advanced solutions to more populations. Global efforts should, therefore, ensure that even the most distant and weakest populations get these innovations, thus narrowing down differences in accessing health services. This future is beyond mere technological progression; it seeks to change human health and well-being like never before.

Although AI and ML have great potential to revolutionize how neurodegenerative diseases are managed, their successful incorporation into healthcare will rely on ongoing research efforts, interdisciplinary collaborations, and robust adherence to ethical standards.

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