Advancing Alzheimer's Care: Exploring the Integration of AI Technologies for Early Detection and Treatment: Challenges and Opportunities

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Abstract

This research explores the growing use of AI integration technologies in the early detection, diagnosis, and treatment of Alzheimer's disease. Through comprehensive literature review, this study examines methods to enhance AD diagnostic precision through machine learning, natural language processing, deep learning, multimodal data integration, explainable AI methods (XAI), and AI-enhanced augmented reality and virtual reality treatment solutions. Beyond technical capabilities, this research identifies a critical gap between AI technological advancement and clinical implementation, and reveals that the challenge of integrating AI into everyday clinical practice and workflow stemming from systematic barriers spanning technical, organizational, and social dimensions. The research proposes diversified workforce collaboration involving AI specialists, healthcare professionals, entrepreneurs, and policymakers as an approach towards optimizing AI tool effectiveness and bridging the implementation gap in Alzheimer's disease care, demonstrating that technical AI capabilities alone are insufficient without coordinated multi-stakeholder deployment strategies.

Tackling this pressing issue is of great significance in the growing field of advanced AI knowledge. Methods to enhance AD diagnostic precision through Deep Learning, Machine Learning, Multimodal Data Integration, Explainable AI methods (XAI), and AI-enhanced Augmented Reality and Virtual Reality treatment solutions are explored. This research further observes the challenge of integrating AI into everyday clinical practice and workflow, and proposes diversified workforce collaboration as an approach towards optimizing AI tool effectiveness in the study and discovery of Alzheimer's disease, the most common type of Major Neurocognitive Disorder (i.e. dementia).

Keywords

Alzheimer's Disease; Deep Learning; Explainable AI; Multimodal Integration; Cognitive Rehabilitation

1. Introduction

1.1. Alzheimer's Disease: An Emerging Challenge

Alzheimer's disease is the most common type of Major Neurocognitive Disorder (Zhang et al., 2024), accounting for 60-80% of global 55 million dementia cases (Gu et al., 2025). Dementia can be defined as a "chronic brain disease that gradually erodes an individual's memory, intellectual abilities, and personality. The most evident symptom during the early stages is the inability to learn and remember new information, while in advanced stages simple tasks such as eating and getting dressed, and ability to speak and think is severely impaired (Igarashi et al., 2023). Dementia is the umbrella term that can be split into primary and secondary components, primary meaning caused by dementia as the main illness, and secondary dementia due to another disease or illness. Primary includes Alzheimer's disease (AD), Lewy body dementia (LBD), Vascular dementia (VaD), Frontotemporal dementia (FTD), Mixed dementia, while secondary include Parkinson's disease dementia (PDD), Huntington's disease, Creutzfeldt–Jakob disease, Wernicke's–Korsakoff syndrome, Traumatic brain injury-induced dementia. This research addresses Alzheimer's disease, due to its nature of being the most common type of dementia, of which its stages can be seen below from (Kumari et al., 2023) in Figure 1.

TABLE 2.2 Stages of Alzheimer's diseases.

S. no.	Alzheimer's stage	Symptoms	Brain changes	Brain regions affected
1.	Preclinical AD	Appears normal but biological changes in brain	Hippocampus	
2.	MCI	Will begin to experience forgetfulness but do not interfere with everyday activities	Hippocampus and entorhinal cortex (medial temporal lobe)	
3.	Mild AD	Forgetfulness, reading problems, poor object recognition, forgetting familiar places, can be diagnosed	Lateral temporal and parietal lobes	
4.	Moderate AD	Clear signs and symptoms, poor judgment, impulsivity, difficulty in communication, confusion, behavior changes	Spreads to frontal lobe	
5.	Severe AD	Loss of motor functions, difficulty in performing daily activities, unaware of time and place, increased assistance and care, may result in death	Spreads to occipital lobe and widespread brain atrophy	

Figure 1: Stages of Alzheimer's Disease (Kumari et al., 2023)

2. AI for Early Detection & Diagnosis of Alzheimer's Disease

2.1. What differentiates Alzheimer's from other types of dementia?

The core pathological hallmarks of Alzheimer's Disease are the abnormal accumulation of amyloid-beta protein (Ab) in the form of senile plaques, tau protein hyperphosphorylation in the form of neurofibrillary tangles, and neurodegeneration (specifically neuronal atrophy and synapse loss) (Karantzoulis & Galvin, 2011), which are all key identifiers to the prediction, diagnosis, and treatment of Alzheimer's. (Zhang et al., 2023).

2.2. Where does Artificial Intelligence (AI) play a role?

The advancement of Artificial Intelligence technologies in society has opened new opportunities that can be used to treat Alzheimer's Disease, and enhance our understanding of the different ways we can combat it as a problem (Gu et al., 2025). The field of AI is focused on enabling computer systems to model human like behavior, through cognitive abilities comparable to human intelligence and thinking. This includes the ability to be attentive to surroundings, comprehend natural language, gain knowledge, and engage in problem-solving behavior and reasoning based in logic (Zhang et al., 2023). The field is expansive and covers many different areas, such as computer vision, machine learning, natural language processing, and robotics (Abadir et al., 2024).

2.3. Predicting the Future

Predictive and foresight capabilities are vital outlooks that can be achieved with AI to forecast the future, identify patterns, and make predictions**.** It can be applied through various ways. This research focuses on the broader categories of machine learning, natural language processing (NLP), and deep learning (DL), a subset of machine learning, to aid in early detection and diagnosis of Alzheimer's.

3. Enhancing Alzheimer's Early Detection and Diagnosis through AI-Powered Insights

3.1. Machine Learning

Machine learning methods are widely applied in high-dimensional clinical data for dementia prediction. This creates a potential for advancing traditional technology, as a large number of patients remain undiagnosed due to costly and time-consuming procedures, with diagnosis requiring a combination of professional clinicians and medical exams, and diagnostic criteria that may not accurately represent the complexity of diverse clinical presentation from patient to patient, such as vascular and FTD subtypes of dementia, where memory impairment may not be the initial prominent symptom (Tsoi et al., 2022). Challenging conventional methods are vital to create breakthroughs towards Alzheimer's care in today's technologically changing world.

Biomarker Analysis

A focus on different biomarkers (indicators) for Alzheimer's disease combined with application of machine learning enhances our detection of Alzheimer's, for example, one study that developed a Machine Learning algorithm capable of classifying AD based on the biomarker of abnormal hippocampal functional connectivity. Additionally, machine learning enables for the capability to not only aid in biomarker identification, but also in the creation of models that combine different AD biomarkers for a more accurate diagnosis. Importantly, the role of AI does not only play in identifying AD itself, but differentiating it from other disorders, such as frontotemporal dementia and vascular dementia (Mirkin & Albensi, 2023).

Other types of biomarkers have been used to advance dementia early detection and diagnosis. Patients that have Alzheimer's disease show early change in the structural integrity of the White Matter in their brain, and the assessment of WM alterations during the MCI (predementia stage of mild cognitive impairment) can be done through DTI, Diffusion Tensor Imaging. The study combined DTI and volumetric MRI data with application of machine learning algorithm Support Vector Mechanism (SVM) (Chang et al., 2021).

The use of AI algorithms in general have allowed us to look at the possibilities of understanding the various types of biomarkers associated with AD, as shown in the below table adapted from (Kale et al., 2024).

Natural Language Processing (NLP)

Natural language processing is a subfield of computer science and AI, that enables computers to understand and communicate with human language, **through use of machine learning** (IBM, 2024). This technology can be used in versatile ways to help in the early detection and prediction of Alzheimer's.

Studies have suggested that one of the earliest signs of cognitive disorders, and possible biomarker for dementia early detection is **language dysfunction.** This dysfunction includes a tendency to repeat words or sentences, and difficulties in word retrieval, such as communication of accurate meanings, verbal naming, etc. NLP plays an important role in analysis of speech and text data, allowing it to extract acoustic, prosodic, and other types of distinct features when analyzing for dementia. NLP has been enhanced through the building of models in the 1990s that address large quantities of empirical language data, and with the use of deep learning, training data, CNN, and RNN, can be quickly analyzed for effective characteristics, without the need for traditional methods of text extraction (such as filtration and clustering), which is time-consuming. Further, NLP has even expanded to spoken dialogue and speech feature extraction, rather than solely text-based, aided through the development of spoken dialogue systems and automatic speech recognition (Tsoi et al., 2022).

Since changes in language can act as a biomarker of cognitive decline, as demonstrated by various studies, it points to the potential of natural language based tools (such as NLP) as a non-invasive, accessible, fast, and cheap tool that can help in detection of these changes, contributing to early diagnosis of Alzheimer's. NLP techniques specifically are used to convert written text into interpretable data, representing the text in a computational way. In comparison to traditional approaches, NLP as a Machine Learning derived technique reduces the burden of manual feature engineering, and increases efficiency of results and the overall analysis, with NLP being applied on texts such as drug reviews, speech transcripts, and health records (Petti et al., 2023).

In a specific study utilizing NLP on clinical notes from patients' electronic records routinely collected by Penfold et al., (2022), researchers developed a machine learning model using NLP that helped to predict mild cognitive impairment (MCI), often diagnosed in the symptomatic pre-dementia phase of ADRD (Alzheimer's Disease and related dementias), in the absence of screening. Following patient and family reported systems, standardized screening instruments such as MMSE (Mini-Mental State Examination) or MoCA (Montreal

Cognitive Assessment), are administered, however screening is not performed routinely due to current insufficient evidence that supports universal use of these instruments for screening. This results in as much as half of cognitive impairment going undetected and undiagnosed in primary care. With the use of machine learning methods that can analyze and extract meaningful information from free-text clinical notes, essentially speeding forward the point to diagnosis, and providing opportunity for earlier psychosocial intervention (Penfold et al., 2022). While the potential of this technology is shown for MCI, MCI may be a precursor of Alzheimer's disease (AD) (Janoutová et al., 2015), thus acting as a first step towards earlier detection of Alzheimer's as a potential precursor to Alzheimer's disease.

3.2. Deep Learning

Deep learning is a **subset of machine learning**, that utilizes multilayered neural networks, known as deep neural networks, simulating the complex decision-making power of the human brain. (IBM, 2024)

Convolutional Neural Networks (CNN)

CNN are a **deep learning model architecture** that can be used through many ways to help in identifying Alzheimer's Disease. They are used for special domains such as image and video-related tasks, and achieve the extraction of features and spatial downsampling through their ability of leveraging layers (Chakraborty et al., 2024).

Facial Expressions

CNN is one of the most representative network structures in deep learning within the field of image processing and recognition. The diagnosis of neurological disorders and disease monitoring can be explored through facial expression analysis of patients with these neurological diseases. One proposed CNN model to achieve this is a specific type of artificial neural network that can calculate convolutions to learn to differentiate characteristics in a dataset. The model can be seen below in figure 2 from (Castillo-Salazar et al., 2019).

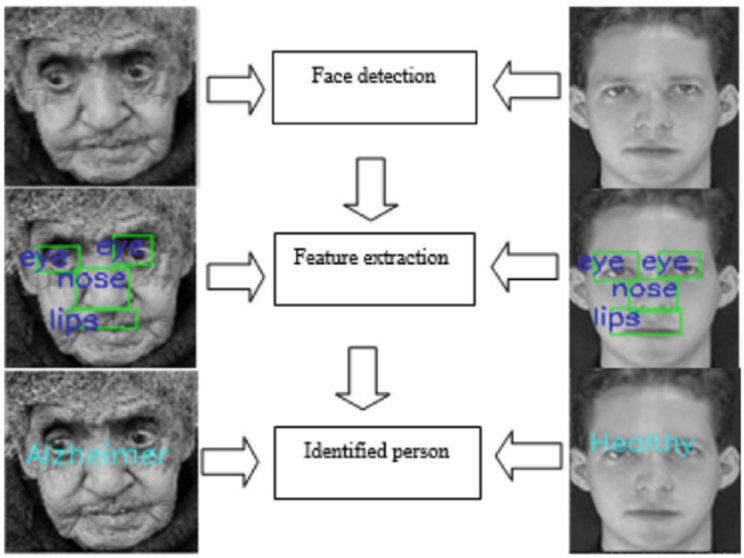


Figure 2: CNN model for facial expression recognition (Castillo-Salazar et al., 2019).

Neuroimaging

The ability of deep learning methods to be applied in neuroimaging is made possible through GPU, Graphics Processing Units, whose advanced processing power, especially for CNN's, allows for good performance in the task of detecting disease through medical imaging (Ebrahimighahnavieh et al., 2020).

Diagnostic indicators of AD during the preclinical stage can be established through neuroimaging, allowing earlier diagnosis and intervention. The most common tools used to diagnose neurodegenerative diseases are MRI, CT, and PET. Generally, the use of modern techniques such as PET and MRI allow for insight into specific changes in the brain strcuture, and other metabolite responses (Tsoi et al., 2022). Further, the use of a *tau PET*, which can detect the detect the presence of a tauopathy (aggregation of abnormal tau protein) in a diagnostic setting, can be combined with CNN to result in novel discoveries. The regional location and topography of *tau PET* signals are considered more important than those of other molecular imaging modalities, which results in observation of how a CNN model has the ability to interact with complex input, and result in the visualization of hallmark features (Chang et al., 2021).

One challenge in neuroimaging however is the analyzation and interpretation of vast amounts of brain imaging data, and thus, there is great potential for the use of artificial intelligence, specifically computer-aided algorithms for integrative analysis to help. Machine learning methods have been developed to detect disease through neuroimaging, with the enhancement of medical imaging, and the greater availability of neuroimaging data. (Tsoi et al., 2022) An example are AI algorithms which can detect subtle changes in the hippocampus region of the brain (an important factor in AD detection in animal studies), through accurate analyzing of complex patterns in MRI scans. This is only one example of how AI is going beyond human capability to aid in more precise and efficient diagnosis of Alzheimer's disease.

When looking to the role of AI based tool of Convolutional Neural Networks (CNN), it can allow for good performance in image classification tasks regarding CT or MRI, through detection of subtle brain scans that could possibly be ignored by human experts. This improves the accuracy of diagnoses, and provides important insights into the progression of the disease (Hasan Saif et al., 2024). Table 1 below displays the way deep learning applications are applied through various types of neuroimaging, and the studies they came from.

Table 1: Deep Learning Applications in Alzheimer's Disease Detection Using Neuroimaging

Neuroimaging Technique	CNN Application	Study
MR Brain Scans	Development of a densely connected CNN with a connection-wise attenuation mechanism (CAM-CNN), achieving 97.35%, 87.82%, and 78.79% accuracy for distinguishing mild AD patients, MCI converters, and stable MCI subjects versus healthy controls.	(Zhang et al., 2021)
MRI Scans	Deep learning methods like CNN were used to develop a model, capable of detecting Alzheimer’s Disease, yielding a testing accuracy of 95.70% and a validation accuracy of 99.41%	(Subasi et al., 2022)
fMRI dataset	Deep learning-based method created to predict early MCI (EMCI), late MCI (LMCI) and AD using fMRI dataset consisting of 138 subjects, performing better than other known models achieving an accuracy of 99.99% in EMCI vs. AD, 99.95% in LMCI vs. AD, and 99.95% in MCI vs. EMCI.	(Odusami et. al, 2022)
FDG-PET images	CNN of Inception V3 was used on **FDG-PET brain images** of 1,002 patients taken from 2005 to 2017, taken from Alzheimer’s Disease Neuroimaging Initiative (ADNI) database, predicting the final clinical diagnosis of AD in an average of 75.8 months prior to the final diagnosis with 82% specificity at 100% sensitivity.	(Ding et al., 2019)
FDG and florbetapir PET	Development of deep CNN–based automatic image interpretation system, for accurately predicting future cognitive decline in patients with MCI.	(Choi et al., 2018)
Tau PET	3D CNN-based classification deep learning models were used to identify morphological phenotypes of tau	(Jo et al., 2020)

	deposition from tau PET, and differentiate patients with Alzheimer's from healthy controls, yielding an average accuracy of 90.8% through five-fold cross-validation.	

4. The Role of Explainable AI (XAI)

Explainable artificial intelligence (XAI) allows human users to comprehend and trust the results and output created by machine learning algorithms. XAI tools has been designed to explain the process, purpose, and perception decision of AI in ways that the common human can understand, thus increasing trust through enhanced clarity of how AI functions. The outcome of its transparency is essential among doctors are other professionals to create trust in the use of neurology disease AI applications, to reap their effective practice and implementation in clinical workflow, and trust the AI outcomes (AbdelAziz et al., 2024). One example of an XAI technique is The Saliency Map, which is used for evaluating prediction models, by providing accurate precise pixel-level interpretation of MRI scans, thus allowing for detailed image analysis through a high-resolution vision. The Saliency Map also highlights the activation of a particular convolution layer through the generation of coarse heatmaps, which designate the most powerful pixels that are contributing to the model's prediction, achieved through the map's use of gradient information. This type of pixel-level granularity provides value critical for medical images, such as in AD detection where subtle patterns can uncover more about the severity of the disorder. Another XAI model called LIME develops superpixels that allow for positive prediction for MCI (Mild Cognitive Impairment indicating early stages of AD), specifically by highlighting the corticol atrophy of the gyri and the expansion of the sulci and ventricles that result from cellular degeneration. Another type of XAI model, the Grad-CAM is able to generate a heat map that allows for identifying distinctive pathological features of AD, which is high activity concentration in regions near the parahippocampal gyrus. (Jordan et al., 2024)

5. Multimodal Data Integration

Multimodal data plays an essential role when utilized through the power of AI. Accuracy of medical predictions can be increased through the integration of multi-modal data, such as clinical, genetic, and imaging information. Deep learning has the ability to fuse these diverse data types, providing a key to unlocking new insights into disease mechanisms and progression, and comprehensive AD prognostication, which ideally would not be achieved in analyzing these types of data in isolation. For instance, clinical data such as cognitive test scores, and medical histories can be fused with genetic information such as APOE genotype, and neuroimaging biomarkers like amyloid-beta deposition and hippocampal volume. These diverse datasets can then be aggregated and analyzed with AI algorithms, to uncover associations between biomarkers of the disease and the disease progression, helping in early identification of individuals that have high risk of rapid cognitive decline. Furthermore, deep learning techniques mentioned previously such as CNN, and other networks such as RNN (Recurrent Neural Networks) have the ability to effectively fuse and analyze multi-modal data in AD applications, where CNN's extract features from various neuroimaging scan techniques, and RNN's process longitudinal clinical data to predict disease progression temporal patterns, enhancing the accuracy and robustness of prognostic models (Kale et al., 2024).

6. Pathways towards treatment

6.1. Exploration of Less Common Disease Presentations

The literature does not seem to provide clear research on how AI technology can directly address the specific biomarker of **neuronal atrophy** in Alzheimer's disease. However, this research proposes a look at indirect methods, such as the preservation of components that are indirectly related to Alzheimer's. For example, one study found that the introduction of synthetic peptide PHDP5 can easily cross the blood-brain barrier, directly target the memory center in the brain, preventing dynamin from being brought out of the cell during one of the major hallmarks of Alzheimer's, the dysfunction of regular tau protein function. (Skov, 2024). Examination of future opportunity to use AI in novel ways can enhance the identification of therapeutic approaches targeting less addressed mechanisms like neuronal atrophy. While various propositions may be developed for targeting AD with AI, scientific viability of each would require further investigation

6.2. Innovative Solutions for Treatment

Augmented Reality

Augmented Reality has the potential to transform cognitive rehabilitation and therapeutic interventions for Alzheimer's disease patients. This application is manifested in different ways; one such way is through an AR model to visualize a brain that has Alzheimer's Disease. A model like such would be used stimulate the effect of drugs that either failed in clinical trials, or are currently in clinical trials. Further, AR can be leveraged as a supportive tool where a surgeon can visualize and see hidden organs enclosed within the human body, enhancing accuracy through improved surgical planning, navigation, simulators, educational tools, therapy, and rehabilitation, eliminating the previously used method called MAGI (Microscopic Assisted Guided Information) (Ramar et al., 2020). Augmented Reality has also been used in different ways, to people make a walk through their own house and will be triggered by an app to memorize their relatives (Kanno et al., 2018). The role of AI has not been explored deeply enough in how it can be used in collaboration with AR. However, one proposed way AI could be used to assist those with Alzheimer's Disease, was a way to integrate medication reminders, presence detection, and emergency alerts to provide comprehensive support and timely intervention to help both patients and their caregivers (Thirrunavukkarasu et al., 2024). Exploring how these potential ideas could merge into AR technology already being used for the treatment and understanding of Alzheimer's may have the possibility to create new avenues of breakthroughs that can advance Alzheimer's care.

Virtual Reality

Virtual Reality is another type of technology being integrated into Alzheimer treatment, showing the possibility to enhance the lives of those with Alzheimer's. The ways of implementation are diverse as in AR. VR setups provide an interactive and immersive environments that are useful to assess cognitive functions more dynamically, and can enhance rehabilitation through cognitive exercises tailored to foster constructive engagement enhanced by cognitive reserve. Furthermore, VR carries the unique offering of a multisensory experience that stimulates multiple sensory channels, creating value for AD patients through improvement of information processing and memorization. (Stasolla et al., 2024). Another innovative approach to VR Alzheimer solutions is the jDome, a devise that combines an exercise bike, dome-shaped projector, and Google Street View technology that work together to allow users to cycle to destinations meaningful to their memory, such as a childhood home, vacation destination, etc. This method of taking people with dementia on a virtual bicycle tour along their paths of memory stimulates both physical aspects but also visuospatial skills and spatial orientation of the user (Gambella et al., 2022). While not evidently researched in depth in literature, the combination of AI and VR technology together to aid in dementia research has been discussed and attempted. One study by Zhong and Silverberg explored the creation of a Virtual Reality art gallery, where a caretaker inputs the memory a dementia patient had, which is then sent to an AI system that generates a painting representing that memory. Once enough paintings are generated, the patient is then handed the VR headset to walk around and interact with the art gallery of their generated memories (Zhong & Silverberg, 2024). Additionally, one study highlighted the potential value of AI in virtual environments if able to modify these environments dynamically according to measured brainwaves reactions of users, through neurofeedback mechanisms, allowing for dynamic reduction of negative emotions, and further fostering positive emotions (Frasson & Ben Abdessalem, 2022).

7. Challenges and Opportunities

7.1. Integration of AI into everyday clinical practice

A gap found in the current literature is a lack of focused research towards integration of AI into everyday clinical practice and workflow, rather than the technical details of AI and how it functions itself if used in the settings. One study suggests that a clinical based-framework is needed to improve thus the application of AI models (Tsoi et al., 2022). To add upon this proposition, this research proposes a multifaceted approach that extends beyond only healthcare and hospital roles, but rather all of the roles that are involved in solving Alzheimer's Disease through collective multidisciplinary and global effort. Challenges of AI systems as critical barriers to real world application (Babu, et al., 2024) must be addressed through a strategic approach, with more research focused on this vital area to drive real clinical outcomes and patient impact.

7.2. Approachable Solutions

Diverse Integration of AD Roles

In order to address the challenge of integrating AI into the clinical workflow, this does not only contain healthcare workers, but rather extends to many roles as outlined by figure 3 below from (Warshaw & Bragg, 2014).

EXHIBIT 1

Types Of Health Care Providers Needed To Care For Adults With Alzheimer's Disease And Selected Care Delivery Tasks, By Provider And Stage Of Disease

	Care delivery tasks		
Type of provider	**Diagnosis and early disease stage**	**Middle disease stage**	**Late disease stage**
Primary care physician, nurse practitioner, physician assistant	Provides diagnosis and initial plan of care; referral for LTSS; and primary management, with 2–3 routine visits per year or hospital care as needed	Provides primary management and referral for LTSS, maintains general health of patient, and monitors for patient safety and caregiver stress	Provides primary management and palliative care, monitors for patient safety and caregiver stress, and assists with planning for end-of-life care
Geriatrician, neurologist, geriatric psychiatrist	May provide primary or consultative care	May provide primary or consultative care	May provide primary or consultative care
Palliative care physician	—[a]	Provides consultative care for distressing symptoms	Provides consultative care for distressing symptoms
Registered nurse, licensed practical nurse	Provides care in office and hospital setting	May provide home or community-based services such as adult day care	May provide home or community-based services or services in an institutional setting
Social worker	Provides consultative care and counseling for patient and family in all care settings	Provides consultative care and counseling for patient and family in all care settings	Provides consultative care and counseling for patient and family in all care settings
Pharmacist	Provides community or hospital consultation	Provides community or hospital consultation	Provides community, hospital, and long-term care consultation
Physical therapist (PT), occupational therapist (OT), and speech therapist (ST)	Provides home safety assessment (OT)	Provides home safety assessment (OT), assessment of ADLs (OT), gait assessment and training (PT), and memory assessment and training (ST)	Provides assessment of ADLs (OT), gait assessment and training (PT), memory assessment and training (ST), and assessment of swallowing disorders (ST)
Dietitian	Provides consultative care for nutrition and diet	Provides consultative care for nutrition and diet	Adjusts diet as swallowing ability declines
Activity professional	—[a]	Develops and implements therapeutic and recreational activities in day care settings	Develops and implements therapeutic and recreational activities in assisted living and nursing home settings
Psychologist	Provides neuropsychological assessment	Provides consultative care	Provides consultative care
Dentist	Provides preventive and corrective services	Provides preventive and corrective services	Provides preventive and corrective services
Direct care worker	Provides respite care in home setting	Provides respite care in home or community-based setting and assistance with ADLs	Provides assistance in home, assisted living, and nursing home settings

SOURCE Authors' analysis. **NOTES** LTSS is long-term services and supports. ADL is activities of daily living, such as bathing and dressing. [a]A person in the early stages of Alzheimer's disease would not need care from a palliative care physician or an activity professional.

Figure 3: Diversity of healthcare roles needed for addressing Alzheimer's Disease (Warshaw & Bragg, 2014).

While the primary care physician may have the physical skills and knowledge of Alzheimer's, their role is only as important as the others, and their interconnection between each other. One framework for implementation into the clinical framework is not one size fits all, and thus needs specialized understanding and collaboration between different specialties of the same as well as diverse type, to fully actualize the positive impact AI can have in Alzheimer's diagnosis, treatment and care when understood and implemented correctly.

Multi-Stakeholder Implementation Framework: Addressing Systematic Barriers to Clinical AI Solutions

Recent systematic analysis identifies seven critical dimensions that must be addressed for successful AI implementation, using the **AI Impacts for Framework Assessment**, namely: Integration; Monitoring, governance, and accountability; Performance quality metrics; Acceptability, trust, and training; Cost and economic evaluation; Technological safety and transparency; and Scalability and impact.

These multifaceted requirements demonstrate why AI development **cannot occur in isolation from holistic implementation considerations** spanning organizational, technical and social impact factors. Additionally, existing frameworks remain insufficient and tend to emphasize technical metrics like algorithm precision,

accuracy and validation, while overlooking critical real-world factors such as clinical impact, practical application and patient outcomes, as well as economic sustainability.

These sociotechnical focus areas and findings from (Jacob et al., 2024) align with the recommendation of this research in driving change through multi-stakeholder collaboration that extends outside of only the clinical perspective In light of this, focusing on the impact within the intersection of the healthcare, technology and entrepreneurship sector could spur both positive patient outcomes. This process proposed would include bringing together the powerful minds of AI specialists, healthcare workers, patients and entrepreneurs in collectively co-creating solutions, as an impactful initiative to ensure all areas of innovation are viably addressed.

Innovators can craft and execute effective solutions for Alzheimer's disease such as through design thinking and human-centered testing, but that is only possible when they are meaningfully integrated alongside traditional healthcare roles and systems. Sustainable solutions can be achieved from a holistic systematic understanding of the healthcare system, with a collaborative approach addressing economic sustainability through entrepreneurs, successful clinical integration with healthcare workers observing patient needs at all types of caregiver levels mentioned previously, in collaboration with technology specialists that have created the technology and can train healthcare workers. This collaboration would fuel a much more successful mechanism that addresses implementation of the current AI solutions in Alzheimer's discussed towards higher feasibility, viability, and desirability to both patients and their diversity of caregivers. Additionally, the integration of policymakers as a stakeholder (Tsvetanov, 2024) could enhance this collaborative effort at a larger implementation level. In modern frameworks, technical performance metrics are emphasized in evaluation more than business viability and long-term financing models, that remain underdeveloped and of which are importance to maintaining the economic stability of the healthcare sector.

Current gaps in Alzheimer's diagnosis demonstrate why the AI technologies discussed in this paper—CNN-based neuroimaging, NLP clinical analysis, and XAI diagnostic tools—require implementation approaches that extend beyond traditional healthcare delivery models. Even within current clinical workflows, diagnostic delays remain substantial. Recent real-world analysis of 870 Alzheimer's patients by (Fazio-Eynullayeva et al., 2024), patients waited an average of 17.3 weeks (approximately 4.3 months) from initial symptom recognition to seeking medical evaluation, followed by an additional 3.0 weeks to receive diagnosis. For nearly half of patients requiring specialist referral, the diagnostic timeline extended to 9.9 weeks from initial consultation to final diagnosis. Furthermore, "a substantial 17 to 20-year lag exists between development of innovations and their widespread adoption, with less than 50% being used in clinical practice" as explained by (Deckert et al., 2024). These problems point to the question of not only the effectiveness of current AI diagnostic tools quantitatively, but their creation and integration, demonstrating that technical capabilities alone are insufficient without coordinated implementation strategies.

As starting points, there have been many attempts already to innovative solutions to Alzheimer's Disease, achieved through similar collaborative multi-stakeholder frameworks. Design and consulting firms, such as IDEO, who utilize design thinking as their problem solving process, have explored innovative approaches to address Alzheimer's disease through their project "Together Senior Health", (IDEO) while McKinsey has partnered with associations towards solving this challenge, such as Davos Alzheimer's Collaborative and UsAgainst Alzheimer's (McKinsey Health Institute). Other innovative approaches such as the Alzheimer Café in Prato Italy were crafted as an idea in 1997 by psychogeriatric Bere Miein in Leiden Netherlands, where those in the first stages of Alzheimer's Disease could meet together in a deinstitutionalized informal space and connect through mutual support in a struggle against their illness and loneliness. In addition, Alzheimer Cafés would also have recreational activities created to stimulate memory, supporting socialization while at the same time psychological and physical well-being (Giusti & Persiani, 2023). This concept of Alzheimer Cafes have spread across the world, and is a popular and easily transferable innovation that is being used to connect people that share the same common struggle (Alzheimer's Disease International).

8. Conclusion: Foresight into Action

To conclude, there is a need to bring together diverse individuals with different expertise through collaboration in solving the growing problem of Alzheimer's disease. The creation and implementation of AI solutions is advancing our society towards finding more effective intervention, which can be effectively addressed through development of frameworks to implement AI effectively for all roles, to subsequently create a successful implementation at the clinical workflow level. As society continues to advance, we see the need for a foresight mindset allowing us to imagine and execute effective use and adaptation of the newest technologies to the growing needs of those with Alzheimer's, to drive a positive societal impact accessible for all. Measurable

outcomes such as economic impact, patient satisfaction, time between successful creation and adoption of AI technology in Alzheimer's are all ways that can enhance future enhancement of this technology, and efforts should be focused on reducing gaps in patient symptom recognition and receiving diagnosis, through strategic collaboration that focuses not only on the technology, but its integration and effective understanding and use.

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