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FRONTAL LOBE DEMENTIA: THE INTEGRATION OF AI TECHNOLOGY FOR THE DIAGNOSIS AND MANAGEMENT

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ABSTRACT

Frontotemporal dementia (FTD), a subtype of frontal lobe dementia, is a progressive neurodegenerative disease characterized by unusual symptoms and difficult diagnosis and treatment. This paper presents a review of ow artificial intelligence (AI) technologies can help transform the challenges outlined above. Latest advances in neuroimaging and machine learning algorithms have already demonstrated great improvements in early detection, differential diagnosis and personalized care planning for frontal lobe dementia. Key AI applications including multi-modal biomarker integration, hierarchical classification models, and computer aided diagnostic systems, all which increase accuracy and reduce diagnostic errors, are synthesized from current research. Additionally, the review emphasizes the use of AI to monitor in real time, and develop novel, patient centered treatment strategies. Challenges to the full realization of the clinical practise benefits of AI include data standardization, ethical concerns and regulatory hurdles. Overall, it presents clear direction for how to use AI technologies to improve outcomes for patients and caregivers, and fundamentally change dementia care.

Introduction

Dementia is an umbrella term for several diseases that impair memory, thinking and the capacity to carry out daily tasks. The condition progresses over time. One of them is dementia and mainly afflict older people (though not everyone will develop it when they get older).[1] Dementia is the result of several diseases and injuries to the brain. However, the most common cause is Alzheimer's disease, a neurodegenerative disorder. Dementia has been re-described in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), as a mild or major neurocognitive disorder of varying degrees

of severity and with many causative subtypes. The International Classification of Diseases (ICD-11) also categorizes dementia as a neurocognitive disorder (NCD) with several forms of subclasses. Dementia is catalogued as an acquired brain syndrome, categorized by a reduction in a cognitive function, and is distinguished from neurodevelopmental disorders. It is also defined as a spectrum of disorders with etiologic subtypes of dementia based on a known disorder, such as Parkinson's disease or Parkinson's disease disorder, Huntington's disease or Huntington's disease disorder, vascular disease for vascular dementia, HIV infection causing HIV dementia, frontotemporal lobar degeneration for dementia with Lewy bodies, and prion diseases. Subtypes of neurodegenerative dementias may also be based on the underlying pathology of misfolded proteins, such as synucleinopathies and tauopathies. The presence of more than one types of dementia at the same time is termed mixed dementia.[2]

Factors that raise the chances of getting dementia include age (more likely in those 65 or older), hypertension (high blood pressure), high blood sugar (diabetes), being overweight or obese, smoking, drinking too much alcohol, being physically inactive, being socially isolated, and depression.[1]

Purpose of the Review

The present review aimed to discuss the potential applications of AI technology in improving the diagnosis and management of frontal lobe dementia. Specifically, it evaluated the potential ole of AI in addressing priority problems in frontal lobe dementia care, such as early detection, personalized treatment planning, and real-time monitoring. Based on the synthesis of the literature reported above, this review provides an assessment of how AI-enabled systems improved diagnostic among patients and caregivers, and facilitate individualized care. The review also highlights the challenges associated with the adoption of AI technology in frontal lobe dementia care, including technological, regulatory, and financial hurdles, and offers recommendations for overcoming these barriers. Overall, this review aims to provide a comprehensive understanding of how AI technology can transform the management of frontal lobe dementia, leading to better patient outcomes and enabling healthcare professionals and caregivers to provide more effective support.

Methodology

Meta analytical review was conducted from the sources like Google Scholar. A total of 50 articles was screened and 10 articles were identified which were in align with stuffy objectives. The keywords were: Frontal lobe dementia, AI technology, diagnosis and management.

Results

Table 1: Shows the articles reviewed and major findings

Sl. No.	Title	Author	Year of Publication	Summary
1	Radiological classification of dementia from anatomical MRI assisted by machine learning-derived maps.	Pierre Chague, Beatrice Marro, Sarah Fadili, Marion Houot, Alexandre Morin, Jorge Samper-Gonzalez, Paul Beunon, Lionel Arrive, Didier Dormont, Bruno Dubois, Marc Teichmann, Stephane Epelbaum and Oliver Colliot	2021	Diagnostic performance was significantly improved by the use of the weight maps for the two junior radiologists in the case of FTD vs EOAD. Improvement was over 10 points of diagnostic accuracy.[13]
2	Early dementia diagnosis, MCI-to-dementia risk prediction, and the role of machine learning methods for feature extraction from	Paolo Maria Rossini, Francesca Miraglia, Fabrizio Vecchio	2022	Graph analysis tools, combined with machine learning methods, represent an interesting probe to identify the distinctive features of physiological/pathological brain aging focusing on functional connectivity networks evaluated on electroencephalographic data

	integrated biomarkers, in particular for EEG signal analysis.			and neuropsychological/imaging/genetic/metabolic/cerebrospinal fluid/blood biomarkers.[3]
3	Applications of artificial intelligence to aid early detection of dementia: A scoping review on current capabilities and future directions.	Renjie Li, Xinyi Wang, Katherine Lawler, Saurabh Garg, Quan Bai, Jane Alty	2022	AI techniques enhance the performance of dementia screening tests because more features can be retrieved froma single test, there are less errors due to subjective judgements and AI shifts the automation of dementia screening to a higher level. Compared with traditional cognitive tests, AI-based computerized cognitive tests improved the discrimination sensitivity by around 4% and specificity by around 3%. In terms of speech, conversation and language tests, combining both acoustic features and linguistic features achieve the best result with accuracy around 94%. Deep learning techniques applied in brain scan analysis achieves around 92%. Movement tests and setting smart environments to

				capture daily life behaviours are two potential future directions that may help discriminate dementia from normal aging. AI-based smart environments and multi-modal tests are promising future directions to improve detection of dementia in the earliest stages.[10]
4	Artificial Intelligence Models in the Diagnosis of Adult-Onset Dementia Disorders: A Review	Gopi Battineni, Nalini Chintalapudi, Getu Gamo Sagaro, Enea Traini, Mohammad Amran Hossain, Giulio Nittari, Giuseppe Losco, Ciro Ruocco and Franceso Amenta	2022	The common adult-onset dementia disease occurring were Alzheimer's disease and vascular dementia. AI techniques associated with MRI resulted in increased diagnostic accuracy ranging from 73.3% to 99%. These findings suggest that AI should be associated with conventional MRI techniques to obtain a precise and early diagnosis occurring in old age.[7]
5	GA-MADRID: design and validation of a machine learning	Fernando Garcia-Gutierrez, Josefa Diaz-	2022	This paper has presented the design and implementation of a machine learning-based framework for the automatic

	tool for the diagnosis of Alzheimer's disease and frontotemporal dementia and using genetic algorithms.	Alvarez, Jordi A., Matias-Guis, Vanesa Pytel, Jorgte Matias-Guis, Maria nieves Cabrera-Martin, Jose L. Ayala		diagnosis, especially, of neurodegenerative diseases. Neuropsychological and neuroimaging assessments provide large, heterogenous datasets, with high possibilities for knowledge mining and the development of diagnostic tools. Out tool is proposed under the XAI perspective to support the clinicians in the diagnosis, as it provides all the steps required to analyse these datasets, from the data processing, feature selection through an evolutionary approach, and modelling of the mentioned diseases. As a case of study, we have evaluated the performance of our approach in the diagnosis of two widespread neurode generative diseases, AD and FTD. It was clearly observed how the proposed framework allows a smooth processing of the cognitive and image assessments, with a high reduction in the number of features needed for the

				diagnosis, and a high accuracy in the classification. A strong effort has been put on the interpretability of the results, showing how a data-centric point of view helps to understand AD and FTD disorders.[14]
6	Artificial intelligence for dementia-Applied model and digital health.	Donald M. Lyall, Andrey Kormilitzin, Claire Lancaster, Jose Sousa, Fanny Petermann-Rocha, Christopher Buckley, Eric L. Harshfield, Matthew H. Iveson, Christopher R. Madan, Riona McArdle, Danielle Newby, Vasiliki Orgeta, Eugene Tang, Stefano	2023	This review focuses on key areas of emerging promise including: emphasize on easier, more transparent data, sharing cohort access; integration of high throughput biomarker and electronic health record into modelling; and progressing beyond the primary prediction of dementia to secondary outcome, for example, treatment response and physical health. [9]

		Tamburin, Lokendra S. Thakur, Illianna Lourida, The Deep Dementia Phenotyping (DEMON) Network, David J. Llewellyn and Janice M. Ranson		
7	AI-based differential diagnosis of dementia etiologies on multimodal data	Chonghua Xue, Sahana S. Kowshik, Diala Lteif, Olivia T. Zhou, V. Carlota Andreu-Arasa, Anika S. Walia, Shreyas Puducheri, Varuna H. Josadanand, Osman B. Guney, J. Diana Zhang, Serena T. Pham, Artem Kaliaev, Brigid	2023	The study, drawing on 51,269 participants across 9 independent, geographically diverse datasets, facilitated the identifications of 10 distinct dementia etiologies. It aligns diagnoses with similar management strategies, ensuring robust predications even with incomplete data. Our model achieved a microaveraged area under the receiver operating characteristic curve (AUROC) of 0.94 in classifying individuals with normal cognition, mild cognitive impairment and dementia. Also, the

		C. Dwyer Chad W. Farris, Honglin Hao, Sachin Kedar, Asim Z. Mian, Daniel L. Murman, Sarah A. O'Shea, Aaron B.n Paul, Saurabh Rohatgi, Marie-Helene Saint-Hilaire, Emmett A. Sartor, Bindu N. Setty, Juan E. Small, Arun Swaminathan, Olga Taraschenko, Cody Karjadi, Meysam Ahangaran, Rhoda Au, Ting Fang Alvin Ang, Jing Yuan, yan Zhou, Shuhan Zhu, Sarah A.		microaveraged AUROC was 0.96 in differentiating the dementia etiologies. Our model demonstrated proficiency in addressing mixed dementia cases, a mean AUROC of 0.78 for two co-occurring pathologies. In a randomly selected subset of 100 cases, the AUROC of neurologist assessments augmented by our AI model exceeded neurologist-only evaluations by 26.25%. furthermore, our model predictions aligned with biomarker evidence and its associations with different proteinpathies were substantiated through postmortem findings. Out framework has the potential to be integrated as a screening tool for dementia in clinical settings and drug trials. Further prospectives studies are needed to confirm its ability to improve patient care.[6]

		Bargal, Bryan A. Plummer, Kathleen L. Poston & Vijaya B. Kolachalama		
8	Transforming text to music using artificial intelligence improves the frontal lobe function of normal older adults.	Masayuki Satoh, Jun Inoue, Jun-ichi Ogawa, Ken-ichi Tabei, Chiaki Kamikawa, Makiko Abe, Ayaka Yoshizawa, Gyo Kitagawa, Yosinori Ota	2024	The online meeting of the otokai, which used music-generative AI, improved the frontal lobe function and memory of independent normal older adults.[16]
9	Artificial Intelligence Diagnosis of Parkinson's Disease From MRI Scans.	Shreya Reddy, Dinesh Giri, Rakesh Patel	2024	In summary, this study highlights the significant potential of AI technology in the realm of neurology, particularly regarding the diagnosis and characterization of PD through MRI scans. Through the utilization of a CNN model trained on an extensive dataset of MRI images, our findings underscore the

				remarkable performance of AI-driven diagnostic tools in accurately discerning PD cases from healthy controls. The exceptional accuracy, precision and efficacy demonstrated by the AI model emphasize its role as a valuable asset in clinical settings, providing clinicians with a robust tool for the early and precise diagnosis of PD. Additionally, our investigation has shed light on the distinct MRI features associated with PD pathology, offering valuable insights into the underlying neuroanatomical alterations driving the disease process. These discoveries not only deepen our understanding of PD but also lay the groundwork for the development of more targeted and effective therapeutic interventions. Looking ahead, continued research and innovation in AI-driven neuroimaging hold the promise of further enhancing diagnostic

				capabilities, advancing patient care, and ultimately alleviating the burden of neurodegenerative disorders like PD. By harnessing the capabilities of AI technology, we have the potential to revolutionize the field of neurology and significantly improve the quality of life for individuals affected by neurological conditions.[15]
10	Applications of Artificial Intelligence in the Neuropsychological Assessment of Dementia: A Systematic Review.	Isabella Veneziani, Angela Marra, Caterina Formica, Alessandro Grimaldi, Silvia Marino, Angelo Quartarone and Giuseppa Marescay	2024	Three main categories of applications are identified: (1) combining neuropsychological assessment with clinical data, (2) optimizing existing test batteries using ML techniques, and (3) employing virtual reality and games to overcome the limitations of traditional tests. Despite advancements, the review highlights a gap in developing tools that simplify the clinicians' workflow and underscores the need for

				explainable AI in healthcare decision making.[5]

Discussion

The literature reviewed focuses on the salient role of artificial intelligence for enhancing diagnostic and treatment of dementia, with a regard of several key aspects:

Diagnostic Precision and Efficacy: It is observed that significant promises in the improvement of the precision of neurodegenerative diagnosis, including dementia-related illnesses, such as Alzheimer's and frontotemporal dementia (FTD). Numerous research studies point towards precision augmented by diagnostic aids like AI when used with modalities, such as MRI, PET and EEG scans.

Techniques and Models: a plethora of ML and AI models has been applied, including SVM, CNN, and deep learning frameworks. These models have been more accurate than traditional diagnostics and, particularly, have made a better distinction between dementia and normal aging as well as between different types of dementia. Hierarchical and explainable AI frameworks have further improved interpretability and clinical utility.

Cross-Correlation with Biomarkers: Neuroimaging-based multi-modal artificial intelligence models haven proven potential in identifying pathological features of dementia. Combination allows for early detection, classification, and tracking of disease progression-all essential for timely intervention.

Emerging Applications: Beyond diagnosis, AI applications will include prognosis, response prediction to treatments, and cognitive assessments using virtual reality and gamification. Further promising applications include AI -driven mart environments and real-time behaviour monitoring.

Challenges: Despite of progress, challenges persist in AI adoption for clinical practice. Theses include data standardization, validation across diverse populations, ethical and privacy concerns, and the need for explainable AI to build trust among clinicians and regulators.

Conclusion

The literature emphasizes the transformative impact of AI in the diagnosis and management of dementia. Artificial intelligence has brought tremendous accuracy and efficiency into diagnostics while also opening up windows for early detection and individualized treatment. However, issues related to standardization, ethics, implementation in a clinical setting must be dealt with to harness the power of AI in healthcare sector. Future research studies should focus on robustness of AI models, relevance across demographics, and transdisciplinary collaboration for holistic strategies for dementia care.

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