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Artificial Intelligence in Dementia Diagnosis: Past, Present, and Future

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Dear Editor,

Dementia can be regarded as one of the biggest medical and health challenges in the last century. Paying attention to recent studies confirms this point. The age-standardized point prevalence of dementia was equal to 777.6 per 100 000 people in the Middle East region and North Africa in 2019, indicating a 3% growth compared to 1990. The point prevalence of the disease has grown during the last three decades,[1] while the number of individuals affected by it is expected to reach 152 million worldwide by 2050.[2] Dementia can be considered neurodegenerative changes in the brain accompanied by symptoms such as impairments in the process of memory, thought, language, functioning, and problem-solving ability.[3] It can also disrupt patients' daily functioning and lower their quality of life. Dementia contains several risk factors such as hypertension, obesity, diabetes, lack of physical activity, and alcohol consumption. It should be noted that in addition to the above factors, this category of disorder becomes more prevalent with age.[2,4]

Artificial intelligence and its algorithms, particularly machine learning (ML) have transformed medical service provision. Numerous studies have been conducted on using artificial intelligence in the fields of neuroimaging and its interpretation,[5] cognitive assessment tests,[6] movement tests,[7] and speech and language tests[8] to diagnose dementia disorders quickly and timely. Many diagnostic tests and modalities for this disease require the presence of trained and specialized staff and also spending a substantial amount of money and time for interpretation. Artificial intelligence can facilitate disease diagnosis, make healthcare service provision more effective with high quality, and make the use of limited financial resources more practical.[9]

Artificial intelligence can contribute to a wide range of diagnostic tests, which are shortly mentioned in the following.

A. Cognitive Tests

In addition to interpreting the final result, using artificial intelligence algorithms in cognitive tests can provide data regarding the participants' behaviors during the test implementation, and it makes the early diagnosis of the disease possible by lowering costs and enhancing accessibility.[2] By final measurement of working memory, visual memory, information processing time, cognitive recognition, and problem-solving ability, on the one hand, and evaluating the participants' functioning during the implementation of the test, on the other hand, artificial intelligence-based cognitive tests based on ML algorithms such as support vector machine (SVM) can provide the basis for the timely diagnosis of dementia disorders with high sensitivity and specificity.[6]

B. Movement Tests

a. The use of ML algorithms, in addition to logistic and regression models, can help diagnose different dementia syndromes with high accuracy by evaluating the patient's movement speed, movement rhythm, asymmetry, gait analysis, and variability.[10]

b. The use of the SVM algorithm by evaluating finger-tapping movements makes it possible to diagnose individuals with dementia with high accuracy.[11]

c. The evaluation of handwriting, graphic drawing, movement fluency features during the test implementation, pauses during writing, and differences in the letter size using artificial intelligence-based methods, in addition to obtaining the data from the patient history and physical examination, can diagnose the disease in the early

stages with high accuracy.[12]

d. The evaluation of eye movements using logistic regression statistical models, SVM, and Naïve Bayes model has been suggested as a criterion for the early diagnosis of dementia in various studies.[2] By investigating memory tests and eye fixating, a study extracted the data related to 13 eye movements, and finally, square regression, ridge regression, and Lasso regression were used for data categorization and disease diagnosis.[13]

C. Speech and Language Tests

In its early stages, dementia can influence language skills and be associated with aphasia, pauses in speaking, and a reduced range of words.[14] The general principles of this group of tests include extracting language patterns and interpreting them in accordance with ML and deep learning (DL) algorithms. The language patterns used in these tests are generally divided into two categories: speech content and speech presentation. Another application of artificial intelligence in this category is testing the photo interpretation and its related conversation and interpreting the data using the ML algorithm, which can diagnose the disease in the early stages with relatively high accuracy.[15]

D. Using Artificial Intelligence in the Interpretation of Imaging Modalities

Magnetic resonance imaging, computerized tomography scan, and, in some cases, positron emission tomography scan play a crucial role in dementia diagnosis. ML algorithms (SVM, and particularly DL) play a significant role in the process of interpreting the data obtained from imaging. Using the above algorithms can increase the diagnosis accuracy and the possibility of timely diagnosis and also provide the basis for greater use of these modalities[16] (Figure 1).

Ultimately, although some artificial intelligence-based modalities have not been widely used in clinical settings yet, we hope that with the expansion of artificial intelligence use, the diagnosis of this disease will be facilitated, and diagnostic accuracy will enhance. Moreover, due to lower costs and less need for the presence of an expert, the provision of these services is made possible in more regions of the world. Thus, given the increasing trend of using artificial intelligence in the diagnosis and treatment of neurological diseases, the need for doctors to get familiar with the application and how to use the above modalities is felt more than ever.
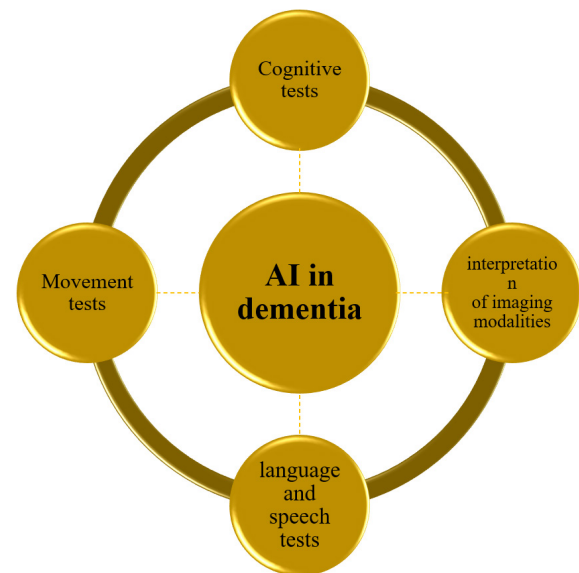
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Figure 1. Artificial Intelligence in Dementia Diagnosis. *Note.* AI: Artificial intelligence

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