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# **Advanced technologies in rehabilitation programs: Role of AI in diagnosis-an updated review**

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**Abstract--Background:** Cognitive decline, particularly associated with aging and neurodegenerative disorders, significantly affects individuals' ability to perform daily activities. Cognitive Rehabilitation Therapy (CRT) offers a non-pharmacological intervention that focuses on regaining or compensating for lost cognitive functions. The integration of Artificial Intelligence (AI) into rehabilitation programs has shown transformative potential in enhancing diagnosis, personalized care, and improving outcomes for patients with cognitive impairments. **Aim:** This updated review explores the role of AI in personalized rehabilitation programs, particularly focusing on diagnosis and Cognitive Rehabilitation Therapy (CRT) and assistive technologies. The aim is to assess how AI technologies, including machine learning (ML) and reinforcement learning (RL), can be leveraged to personalize cognitive rehabilitation interventions and improve patient outcomes. **Methods:** The review synthesizes studies on AI-driven rehabilitation interventions, including personalized rehabilitation applications, virtual reality-based treatments, and assistive robotic technologies. It examines the efficacy of reinforcement learning and AI-powered platforms in creating adaptive, personalized rehabilitation environments. The review also explores applications for diverse neurological conditions such as dementia, multiple sclerosis (MS), and autism spectrum disorder (ASD). **Results:** The review identifies several AI-driven interventions, such as personalized apps for dementia and MS, virtual reality treatments for cognitive impairments, and social robots that aid memory training. The results demonstrate that AI technologies improve cognitive function, emotional well-being, and physical independence, particularly in patients with neurological disorders. AI-driven systems can adapt to patients' performance, offering real-time feedback and

creating personalized rehabilitation plans. **Conclusion:** AI technologies have a significant potential to enhance personalized rehabilitation programs, offering adaptive, cost-effective, and accessible solutions. The integration of AI in CRT can lead to better patient engagement, improved cognitive function, and increased independence in daily activities. However, barriers such as cost, trust in technology, and accessibility remain challenges that need to be addressed for broader adoption.

**Keywords**---Cognitive decline, Cognitive Rehabilitation Therapy, AI, Personalized rehabilitation, Machine learning, Reinforcement learning, Neurodegenerative diseases, Assistive technology, Virtual reality, Rehabilitation apps.

## Introduction

Cognitive decline, characterized by the deterioration of cognitive abilities, is commonly observed with aging and may become more severe when caused by medical conditions such as neurocognitive or neurodegenerative disorders. The loss of skills such as reasoning, executive functioning, attention, memory, and other cognitive functions can significantly impede an individual's ability to perform daily activities. The lack of adequate treatment for individuals with cognitive impairments poses a critical concern. Hence, ensuring access to appropriate care and rehabilitation facilities is essential for managing cognitive impairments [1].

Cognitive Rehabilitation Therapy (CRT) is a therapeutic intervention designed to assist individuals with cognitive decline in recovering lost cognitive abilities or acquiring new ones [2]. This approach encompasses two types of rehabilitation: restorative, which focuses on regaining lost functions, and compensation, which helps adapt to deficits. CRT is a non-pharmacological treatment method that employs problem-solving strategies to enable individuals with cognitive impairments to maintain daily activities [2]. Furthermore, cognitive training may also be applied to enhance cognitive performance in individuals without impairments, improve academic outcomes among students, or strengthen cognitive reserves in older adults [3]. The integration of digital technologies, particularly AI, has transformed healthcare and mental health services by providing diverse applications [4]. Machine learning, specifically reinforcement learning, has facilitated personalized treatment interventions [5]. AI in mental health extends beyond traditional roles such as diagnosis and drug recommendations, offering innovations like virtual therapy sessions using AI chatbots or virtual reality platforms. These platforms provide accessible support in a safe environment, allowing patients to express emotions freely, thereby overcoming geographical barriers [6][7]. Technology-based interventions are also highly accessible and cost-effective, enabling individuals to benefit from them conveniently at home [8][9][10].

Various CRT interventions for conditions such as mild cognitive impairment (MCI) or neurocognitive disorders can be delivered through smartphone apps, web-

based applications, or gaming consoles without requiring costly equipment [9]. Such interventions can be adaptive by employing reinforcement learning agents that interact with users during exercises, creating personalized training plans based on performance, thereby maximizing the effectiveness of cognitive training programs [11]. Additionally, technological advancements have facilitated traditional interventions via social robots, eliminating the reliance on paper-based methods [12]. Social robots, which include humanoid types like MATILDA, MERO, and NAO, as well as zoomorphic types like AIBO and PARO, have shown promise in engaging participants in memory training programs [12][13][14][15]. However, further research is needed to refine training components and robot responsiveness. Despite the advantages of technology-based CRT, challenges remain, particularly in adopting rehabilitation techniques. Key barriers include cost, trust in technology, access, lack of education, insufficient awareness, inadequate training, and user-unfriendly interfaces [16][17]. Importantly, AI should not replace human expertise in healthcare but should complement it. The synergy of human judgment and AI-driven insights has the potential to enhance diagnoses, personalize treatment plans, and improve overall patient care.

### **Preliminary Rehabilitation**

Neurological populations, including individuals with neurodevelopmental disorders, neurodegenerative diseases, strokes, disorders of consciousness, or rare genetic syndromes, often face significant challenges in meeting environmental demands. These challenges may encompass intellectual disabilities, severe motor impairments, sensory deficits, and communication delays, such as speech impairments. Such conditions frequently necessitate reliance on family members and caregivers, especially for individuals with acquired brain injuries [24][25]. This dependency can adversely affect their quality of life, social status, and self-perception, creating significant barriers to social desirability [26][27]. To address these challenges, assistive technologies, new technologies, and AI-based interventions have been proposed as potential solutions [28–30]. Assistive technology encompasses devices, tools, or equipment designed to enhance self-determination and independence by creating functional connections between an individual's capabilities and environmental demands [11]. Additionally, advanced technologies such as virtual and augmented reality, mixed and extended reality, and serious games offer immersive environments that replicate real-life scenarios for assessment, education, and rehabilitation purposes [31][32]. AI, particularly reinforcement learning, provides interactive, personalized solutions by adapting to user performance through feedback and reinforcement [33][34]. These technology-based solutions, when integrated with standard cognitive rehabilitation methods, can be employed in clinical and daily settings for both diagnostic and recovery objectives, offering valuable support to neurological populations [35][36].

### **Cognitive Rehabilitation: Approaches and Strategies**

Cognitive rehabilitation (CR) focuses on systematic interventions to restore or improve cognitive functioning by either (a) enhancing previously acquired skills or (b) developing new cognitive strategies to compensate for neurological impairments [37]. CR employs both restorative and compensatory strategies.

Restorative approaches rely on principles of learning and neuronal plasticity, wherein repetitive exercises enhance neural connectivity and facilitate the recovery of impaired functions. Conversely, compensatory strategies involve the substitution of damaged neural pathways with alternative mechanisms to achieve specific objectives. These two approaches can be integrated into comprehensive rehabilitation programs, as the simulation of cognitive processes during compensatory training can support and enhance neural connectivity [38][39]. CR can be delivered through conventional methods or via computerized solutions using information and communication technologies (ICT). Computer-mediated interventions offer advantages over traditional approaches, such as managing human resources, time, and costs. They also provide adaptive features like dynamic task difficulty adjustments, personalized stimuli, and immediate response tracking tailored to the participant's needs [40–42].

### **Categorizing Technology-Aided Interventions**

The review identifies seven primary categories of interventions. Four focus on treatment methods, while the remaining three are centered on specific neurological disorders:

1. **Personalized Rehabilitation Apps:** Customized apps and software tailored to support cognitive rehabilitation across various neurological conditions, incorporating diverse technological options.
2. **Rehabilitation through Assistance:** Use of physical robots or technology-driven programs to aid individuals with profound neurological impairments in performing daily tasks.
3. **Rehabilitation for Neurological Disorders:** Cognitive-behavioral therapy interventions designed to support independent functioning in individuals with neurological conditions like depression and anxiety.
4. **Rehabilitation for Developmental Disorders:** Targeted interventions for children and adolescents with neurodevelopmental delays, utilizing technology-based programs to foster independence.
5. **Virtual Reality-Based Rehabilitation:** Immersive virtual reality environments replicating real-life scenarios to enhance ecological validity, behavioral monitoring, and experimental control.
6. **Rehabilitation for Neurodegenerative Diseases:** Technological interventions addressing extensive cognitive or motor impairments associated with neurodegenerative conditions.
7. **Telerehabilitation for Cardiovascular and Other Diseases:** Remote rehabilitation solutions encompassing evaluation, intervention, supervision, education, and consultation for various health conditions.

These categories provide a broad, though not exhaustive, overview of AI and technology-based treatments for neurological disorders, offering readers insights into innovative approaches for improving patient outcomes.

### **Artificial Intelligence (AI):**

Artificial Intelligence (AI) refers to the development of computer systems capable of performing tasks typically requiring human intelligence, such as reasoning, perception, problem-solving, and language processing. AI has significantly

transformed our way of living, revolutionizing technology by supporting, enhancing, and inspiring human activities in practical ways. It represents a computational approach enabling computers to learn from data and approximate solutions to complex problems. The flexibility and robustness of AI have facilitated its application across diverse fields, including robotics, airline flight control, and healthcare. In psychology, learning is understood as an experience-based process that leads to behavioral or cognitive changes, enhancing performance [43]. Machine Learning (ML), a subset of AI, focuses on the scientific study of algorithms and statistical models that enable computer systems to perform specific tasks autonomously. ML algorithms build mathematical models using training data to make predictions or decisions without explicit programming for the task [44]. ML encompasses various paradigms, including supervised, unsupervised, online, batch, meta-learning, and reinforcement learning, with applications in domains such as medicine, computer vision, agriculture, email filtering, and speech recognition [11].

Among ML techniques, Reinforcement Learning (RL) is an adaptive method that trains systems through interaction with their environments. RL improves decision-making by adapting to feedback signals, making it highly effective for solving complex problems [45][46]. Deep Learning (DL), a rapidly growing field within data science, builds on artificial neural networks to process unstructured data like images, videos, text, and voice. Although its origins trace back to the 1980s, DL has achieved its full potential only in recent years [47]. Neural networks used in DL are trained end-to-end to simplify complex challenges. However, steep learning curves and domain-specific restrictions have hindered its widespread adoption in various industries [48]. This dynamic landscape of AI, ML, and DL demonstrates their transformative potential, while also highlighting the need to address usability and industry-specific challenges for broader application.

### **AI, Diagnosis, and Rehabilitation Programs: Personalized Rehabilitation Applications**

Adaptive rehabilitation is tailored to the unique needs and impairment levels of individuals, often delivered through web or smartphone applications, or a combination of both. This section reviews studies focused on using these applications as treatment interventions for various impairments.

#### **1. Dementia Cognitive Improvement**

- A custom Android application was developed for dementia patients, targeting four cognitive domains: concentration, executive functioning, language, and memory. Over a month, participants trained with and without reinforcement learning (RL), showing significantly better outcomes when RL was employed [49].

#### **2. Multiple Sclerosis (MS)**

- A personalized adaptive system integrated computerized cognitive training with RL to rehabilitate MS patients with mild cognitive impairments. Performance, measured using the Paced Auditory Serial Addition Test (PASAT), improved markedly for participants trained with RL [50].

#### **3. Mild Cognitive Impairment (MCI) Detection**

- An RL framework used disease-specific lexical probabilities to distinguish between normal and MCI individuals in conversation-based diagnostic settings. This approach demonstrated higher diagnostic accuracy compared to traditional supervised learning methods [51].

#### **4. Depression and Anxiety Interventions**

- Computer-assisted cognitive behavior therapy (CBT) was evaluated for its efficacy in treating depression, especially among individuals in primary care with limited internet access or education. Smartphone-assisted interventions for generalized anxiety disorder showed significant improvements in anxiety and stress metrics following six-month follow-ups [68][69].

#### **5. Autism Spectrum Disorder (ASD)**

- Mobile applications for children with ASD were designed with simplified icons, minimal colors, and user-friendly features to enhance social, language, and numeracy skills. Apps specifically tailored to the sensory and cognitive needs of children with ASD showed promise in improving engagement and learning [52][53].

#### **6. Attention Deficit Hyperactivity Disorder (ADHD)**

- A cognitive rehabilitation program using Unity3D technology integrated games targeting ADHD symptoms. The games, combined with virtual reality components, improved social integration and cognitive function in children [70].

#### **7. Cognitive Rehabilitation for General Impairments**

- Brain m-App was developed for home-based cognitive rehabilitation, employing virtual reality and 360-degree videos. A 10-day program yielded improvements in executive function and memory [71].

#### **8. Older Adults and Fall Risk Reduction**

- An interactive physical-cognitive training system for older adults featured exercises and cognitive games. Initial feedback highlighted its engaging design, although further studies are needed to confirm its effectiveness in reducing fall risks [72].

#### **9. Serious Games in Cognitive Rehabilitation**

- Studies comparing Serious Games (SG) to traditional methods for cognitive rehabilitation noted SG's superiority in training effectiveness and data generation. Applications like CogniFit and Sea Hero Quest effectively targeted cognitive skills such as attention and memory [73].

#### **10. Mild to Moderate Dementia**

- The GREAT Cognitive Rehabilitation intervention received positive feedback for its implementation strategy, which involved leadership identification, planning, and practitioner training. Practitioners and caregivers highlighted its usability and impact on dementia care [74].

#### **11. Exergames for Neurocognitive Disorders**

- A stepping exergame was evaluated for older adults with major neurocognitive disorders (MNCD). Using mixed methods, the study concluded that the game was user-friendly and suitable for

improving physical and cognitive health in long-term care settings [75].

These findings demonstrate the growing role of personalized rehabilitation apps in addressing diverse impairments, emphasizing their potential for improving patient outcomes while integrating seamlessly into everyday environments.

### **Rehabilitation Through Assistance**

Patients with Down syndrome, brain stroke, and severe dementia are often unable to perform their activities of daily living (ADL) independently. Hiring a professional caregiver to assist such individuals is costly. Therefore, rehabilitation through assistance, such as robot support and AI-based dialogue therapists or simulators, can help individuals perform their daily activities. In a study, the authors developed an assistive system to help Alzheimer's patients perform daily tasks, such as drinking a beverage. The system extracts the position of the patient's body joints and the exact position of the patient during an activity. The RL agent analyzes all activities and generates an alert in case of an anomaly. The system's real-time effectiveness was evaluated using precision and recall metrics, proving it to be the most suitable system for assisting Alzheimer's patients in performing daily activities. In [54], the authors proposed a support system to help Alzheimer's patients perform tasks independently. This assistive system consists of human activity recognition (HAR) systems—one using 2D skeleton data and another using 3D skeleton data followed by CNN and transformers. The work concludes by comparing the proposed system's performance to determine the most suitable assistive system. In another study [55], an AI food assistance system for Alzheimer's patients is considered. Alzheimer's patients are at high risk of dehydration, malnutrition, or overeating due to memory loss. This system assists the patient's activities through video, monitors their timing of eating and drinking, and generates audio messages to prevent overeating or remind the patient to eat. The results showed the system's efficiency, reducing the need for professional caregivers. In [56], an assistive robot named LOLA2 was developed to assist individuals with neurodevelopmental disorders. The robot monitors the real-time actions of a patient by tracking the time and actions of the activity. The results obtained were promising enough to conclude that LOLA2 can assist individuals with neurodevelopmental disorders.

The M3Rob rehabilitation platform, which integrates haptic robotics, neurofeedback, and augmented reality to aid in stroke rehabilitation. The M3Rob platform uses electromyography (EMG) and electroencephalography (EEG) signals to identify the intent of hand and wrist movements, enabling personalized assistive therapies for neuromotor and cognitive rehabilitation. The research develops an ontology-based cognitive assistance framework for ambient assisted living (AAL) systems, providing adaptive dialogue and assistance to individuals with cognitive impairments. The model uses speech acts theory to translate cognitive assistance into adaptive assistive messages. The model's usability and applicability were demonstrated in a real-life scenario, showcasing its effectiveness in providing graded guidance messages. The authors examined the outcomes of rehabilitation using gait robot-assisted training in stroke patients with hemiplegia. The experimental group received stroke rehabilitation using gait

robot-assisted training, while the control group received conventional rehabilitation. The gait robot-assisted rehabilitation with goal setting improved stroke self-efficacy, balance ability, gait ability, and health-related quality of life in patients.

### **Rehabilitation for Neurological Disorders**

Neurological disorders include a broad range of conditions like brain tumors, head injury, epilepsy, and syndromes. This section focuses on studies related to the rehabilitation of serious mental illness, vascular disorders, and depression/anxiety. The methodology developed in [57] aims to improve cognitive behavioral therapy (CBT), particularly for the treatment of depression, by revealing the brain patterns of those with depression and suggesting new ways to help individuals through thinking and learning. This cross-sectional cohort study reveals that understanding the association of RL with brain regions of individuals without depression can help improve CBT and assist clinicians in treating people with depression. A study investigates the differences in RL parameters between patients with anxiety or depression and control individuals. The authors also performed a novel simulation meta-analysis alongside conventional meta-analysis. A series of random-effects meta-analyses were conducted after extracting individual-level parameters to examine whether any of the most commonly reported parameters showed differences between control individuals and patients. A recent study explores the efficacy of Computerized Cognitive Training (CCT) on functional, psychosocial, mood, and cognitive outcomes, and daily functioning in adults with depression. The authors investigated this in comparison to passive or active control. They also examined the intervention design factors that may moderate CCT effects across each domain of study. The quality and strength of the evidence for CCT in depression were also evaluated. The study aimed to improve functional outcomes for people with serious mental illness. Modern ICTs, such as mobile apps, provide solutions to help patients with serious mental illness improve their functional outcomes. The program offers psychiatric rehabilitation to help patients enhance their social and cognitive disabilities.

The work in [60] considers the cortical-striatal pathway for two common neurodevelopmental disorders. Differentiation between corticostriatal dysfunction in learning and attentional disorders has been studied through RL approaches by observing the cognitive processes involved. The entire study was conducted with males only, but the findings suggest a difference in patterns of learning disorders and attentional disorders for model-based RL and model-free RL. The efficacy of a computer-aided cognitive training program was investigated on depressive symptoms, behavioral symptoms, and cognitive measures in patients with major vascular neurocognitive disorder. The subjects were divided into a control and treatment group, and all participants received a neuropsychiatric inventory, the Aasberg depression rating scale, the Montgomery, and the mini-mental state examination. A review study highlights machine learning approaches in post-stroke rehabilitation for functional recovery prediction and prognosis. Five electronic databases were analyzed during the study. The authors extracted the validation approach, the algorithm used, the scheme for feature extraction and selection, outcome assessments, population characteristics, and health

conditions. The research is a telerehabilitation program for neurocognitive disorder patients. The research is a controlled trial that compares the Core and HomeCore programs—one for hospital trials and the other for distance treatment. The program offers a wide range of cognitive exercises such as those for episodic long-term memory, executive functioning, working memory, attention, and processing speed.

A review of the applications of LEAP motion in various psychological domains, especially in interventions for neurocognitive and neurodevelopmental disorders. The survey discussed studies on autism spectrum disorder and attention-deficit hyperactivity disorder (examples of neurodevelopmental disorders), and MCI and dementia (examples of neurocognitive disorders). The study discusses the importance of cognitive rehabilitation for individuals with type 2 diabetes. It evaluates the effectiveness of a program called Memory, Attention, and Problem-Solving Skills for Persons with Diabetes (MAPSS-DM), exploring how it enhances cognitive functioning and diabetes management. The findings suggest that the intervention group showed improvement in memory and executive functioning, along with better diabetes self-management. The review work found that cognitive rehabilitation programs using cognitive training, compensatory strategies, or a combination of both can improve cognitive function for breast cancer survivors with chemotherapy-related cognitive impairment. However, a clear recommendation could not be established due to methodological concerns and varied program parameters. The research done focuses on improving cognitive rehabilitation for individuals with speech disorders through the use of machine learning. By combining the machine learning approach with data collected from EEG and Kinect sensors, the model has achieved promising results for real-time scenarios, improving overall quality of life. The work analyzes the relationship between delirium, physical exercise, and rehabilitation. There is a strong connection between delirium and physical functioning. Delirium affects both cognitive and motor functions, so the motor component of delirium should also be considered when designing interventions or strategies. In a study, a digital intervention was tested in adult patients with major depressive disorder and cognitive impairment. Improvement in sustained attention was observed with AKL-T03 compared to the control intervention. Further research is needed to understand the clinical consequences and impact of AKL-T03.

## **Conclusion**

The integration of Artificial Intelligence (AI) into rehabilitation programs has the potential to revolutionize cognitive rehabilitation, making treatments more personalized, adaptive, and accessible. As cognitive impairments are a significant concern, particularly in aging populations and those with neurodegenerative diseases, AI offers a promising approach to enhancing Cognitive Rehabilitation Therapy (CRT). Through personalized applications, reinforcement learning, and virtual reality-based therapies, AI-driven interventions are able to tailor rehabilitation programs to the specific needs of patients, improving both their cognitive abilities and emotional well-being. One of the key advantages of AI in rehabilitation is its ability to create adaptive, interactive, and individualized treatment plans. These AI-driven systems, particularly those utilizing reinforcement learning, adjust in real time to the patient's performance, ensuring

that the treatment is both challenging and achievable. For conditions such as dementia, multiple sclerosis, and autism spectrum disorder, AI has demonstrated effectiveness in enhancing cognitive function and providing support for daily living activities. Furthermore, AI technologies in rehabilitation are not only limited to cognitive improvement but also extend to emotional and social support, as seen in applications involving social robots and virtual therapy platforms. These technologies have been instrumental in overcoming barriers to access, allowing patients to engage in therapy remotely, which is particularly beneficial in rural or underserved areas. Despite these advancements, challenges such as the cost of implementation, user trust in technology, and the need for further training in healthcare settings persist. Overcoming these barriers will be essential for the widespread adoption of AI-driven rehabilitation programs. Additionally, the balance between AI technology and human expertise remains crucial; AI should not replace healthcare professionals but rather complement their expertise, enhancing their ability to provide effective care. In conclusion, AI has demonstrated its transformative potential in personalized rehabilitation programs. With continued research and development, AI-driven interventions have the capacity to improve patient outcomes, offering a more efficient, accessible, and scalable approach to cognitive rehabilitation. However, addressing the barriers to adoption will be essential in realizing the full potential of AI in healthcare and rehabilitation.

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**الملخص:**

**الخلفية:** يؤثر التدهور المعرفي، خصوصًا المرتبط بالتقدم في العمر والاضطرابات التنكسية العصبية، بشكل كبير على قدرة الأفراد على أداء الأنشطة اليومية. توفر العلاج المعرفي (CRT) تدخلًا غير دوائي يركز على استعادة أو تعويض الوظائف المعرفية المفقودة. أظهر دمج الذكاء الاصطناعي (AI) في برامج التأهيل، والتشخيص إمكانيات تحويلية في تعزيز الرعاية الشخصية وتحسين نتائج المرضى الذين يعانون من الاضطرابات المعرفية.

**الهدف:** تستعرض هذه المراجعة المحدثة دور الذكاء الاصطناعي في برامج التأهيل الشخصية، مع التركيز بشكل خاص على التشخيص والعلاج المعرفي (CRT) والتقنيات المساعدة. الهدف هو تقييم كيفية الاستفادة من تقنيات الذكاء الاصطناعي، بما في ذلك التعلم الآلي (ML) والتعلم المعزز (RL)، لتخصيص التدخلات العلاجية المعرفية وتحسين نتائج المرضى.

**الطرق:** تجمع المراجعة الدراسات المتعلقة بالتدخلات العلاجية المعتمدة على الذكاء الاصطناعي، بما في ذلك التطبيقات الشخصية للتأهيل، العلاجات المعتمدة على الواقع الافتراضي، والتقنيات الروبوتية المساعدة. كما تستعرض فعالية التعلم المعزز ومنصات الذكاء الاصطناعي في إنشاء بيئات تأهيلية تكيفية وشخصية. كما تستكشف المراجعة التطبيقات للأمراض العصبية المتنوعة مثل الخرف، والتصلب المتعدد (MS)، واضطراب طيف التوحد (ASD).

**النتائج:** تحدد المراجعة العديد من التدخلات المدفوعة بالذكاء الاصطناعي، مثل التطبيقات الشخصية للخرف وMS، والعلاجات المعتمدة على الواقع الافتراضي للتدهور المعرفي، والروبوتات الاجتماعية التي تساعد في تدريب الذاكرة. تظهر النتائج أن تقنيات الذكاء الاصطناعي تحسن الوظائف المعرفية، والرفاهية العاطفية، والاستقلالية البدنية، خاصة في المرضى الذين يعانون من اضطرابات عصبية. يمكن لأنظمة الذكاء الاصطناعي التكيف مع أداء المرضى، مما يوفر ملاحظات فورية ويخلق خطط تأهيل شخصية.

**الخلاصة:** تمتلك تقنيات الذكاء الاصطناعي إمكانيات كبيرة لتعزيز برامج التأهيل الشخصية، من خلال توفير حلول تكيفية وفعالة من حيث التكلفة وقابلة للوصول. يمكن أن يؤدي دمج الذكاء الاصطناعي في العلاج المعرفي إلى زيادة تفاعل المرضى، وتحسين الوظائف المعرفية، وزيادة الاستقلالية في الأنشطة اليومية. ومع ذلك، تظل هناك تحديات مثل التكلفة، والثقة في التكنولوجيا، وإمكانية الوصول التي يجب معالجتها من أجل التبني الأوسع.

**الكلمات المفتاحية:** التدهور المعرفي، العلاج المعرفي، الذكاء الاصطناعي، التأهيل الشخصي، التعلم الآلي، التعلم المعزز، الأمراض التنكسية العصبية، التكنولوجيا المساعدة، الواقع الافتراضي، تطبيقات التأهيل.