ROBOTICS FOR NEUROREHABLITATION OF NEURODEGENERATIVE DISORDERS

Abstract

Crippling disorders of the nervous system place great burdens on health and social life for people around the world. Neurodegeneration is a major factor and is often the cause of disability in many disorders that are rarely considered impaired - for example, multiple sclerosis, epilepsy, congenital metabolic disorders, schizophrenia, and even tissue. Neurological degenerative disorders have a significant impact on the technical, communal and personal level of affected person and can trigger absolute failure of any type of daily activity. Reintegration is effective and powerful procedure in which affected person with a disability is aided to obtain acquaintance and skills to enhance their corporeal, mental and communal working. The communication between the human cognizance and the physical authenticities has been shown to enhance intellect. Organically, this result cannot be attained without the action of other types of neural plasticity, for example strengthening or reducing the strength of synaptic communication, rehab of synaptic networks, reconstruction in dendritic nerves, reform of neural morphology, or mutation of electrical pleasure. Direct evidence of basic cellular variations at each neuron, however, is beyond the scope of existing intellectual patterns of active brain. This review is done to evaluate that robotics is evident in neurodegenerative disorders for the specific disabilities.

Keywords: Parkinson's disorder (PD), Alzheimer's disorder (AD), Amyotrophic lateral sclerosis Disease (ALS), Robotics, Artificial intelligence and Neuroplasticity

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I. INTRODUCTION

Crippling disorders of the nervous system place great burdens on health and social life for people around the entire world. Parkinson's disorder (PD), Alzheimer's disorder (AD), and amyotrophic lateral sclerosis (ALS) are the three major neurodegenerative disorders. The incidence and outbreak of these disorders are greatly exacerbated by aging; therefore, the number of cases is expected to elevate in the inevitable future as life expectancy in many countries continues to increase[1].

Neurological degeneration is a major factor and is often the cause of disability in many disorders that are rarely considered impaired - for example, multiple sclerosis, epilepsy, congenital metabolic disorders, schizophrenia, and even tissue[2].

Neurological degenerative disorders are caused by a gradual decrease and demise of neurons (cells accountable for the functioning of the neuronal organization). This decline can influence physical activity and brain processing, leading to dementia (continuous decline of cognition that affects some aspects of remembrance, reasoning/thinking, behavior, speech/linguistic, counting, learning and emotional abilities. [3].

These disorders are one of the major health and socioeconomic drawback of our time, involving people of all ages. The causes of their appearance are unknown; they can be a variety of disorders: Alzheimer's Disorder (AD); Parkinson's disorder (PD); Amyotrophic Lateral Sclerosis disease (ALS); Multiple Sclerosis (MS); Huntington's disorder (HD); Machado-Joseph's Disorder; Family of Amyloid Polyneuropathy, better known, Alzheimer's disorder and Parkinson's.

Neurological degenerative disorders have a significant impression on the technical, socioeconomic and family status of patients and can lead to total failure of any type of daily activity. For example, patients may have: motor problems; difficulty in breathing due to involvement of respiratory muscles; cognitive issues or memory loss gradually (which may affect the memory of all that has been learned over a lifetime) [4].

Neurological Reintegration is primarily about paralysis. Reintegration is an effective and powerful process in which a disabled person is helped to gain knowledge plus skills to enhance their mental, corporeal and social integration. This process can be reduced to three key areas:

- Ways to decrease motor disability
- Strategies designed to learn new skills, as they increase performance
- Strategies that will help the patient to change the surroundings, both corporeal surroundings and societal influences, so that a certain disability can be accompanied by less disability [5].

The renewal process is set in goal setting. The first and foremost goal to be set is the long-term achievement of the plans. For many the long-term goal could be to return to a normal life. For some, it may simply be to return home and stay at home with the help of caregivers. Once a long-term goal is achievable and achievable then small steps are needed to achieve that goal. If, for example, the long-term goal is to move in a particular environment independently without the use of resources, attaining that goal may be out of reach for many short-term goals [6]. This progression, for instance, can twitch with living deprived of support, and then stop without any support, and then go with the help of an individual, then go through resources, and lastly achieve the attainment of independence. Objectives should be straightforward. There is no basis for setting clear and unambiguous goals as a correctional team or person with a disability will not be able to monitor their status [7].

What it means to set realistic goals is that both the individuals with a disability and the health team must recognize when the goals have been attained. Therefore, it is equally essential for all the targets to have a valid and reliable conclusion. There are many measures which are formulated to supervise disability for example how mush person can person a particular function moreover, how the quality of life is affected thus this can be helpful in assessing progress towards a long-term goal. Short-term goals often require particular outcomes. Some of these steps need to be simplified and fast. In terms of rental accommodation, the simplest, fastest and most reliable route can be set to travel more than 10 meters. It is vital to recall that any outcome of the results used must be clear, effective, and reliable otherwise we should not use them. It is also worth memorizing that while objective measurement is important, a person with a disability perspective on progress towards goal-oriented interventions can help rehabilitate patients with non-neurodegenerative disorders, and can be an important ingredient in replacing lost brain functions - computerized (BCI) interface that wheels robotic structures [8].

The interface between the human being mind and the physical reality have shown to enhance intellectual functions. Organically, this result cannot be attained without the action of other types of neuronal plasticity, such as strengthening or reducing the strength of synaptic transmission, remodeling of synaptic connections, reconstruction of dendritic nerves, restructuring of neural morphology, or mutation of electrical pleasure. Direct evidence of basic cellular variations at the level of each neuron, however, is beyond the reach of current thinking patterns of active brain. However, magnetoencephalography (MEG), electroencephalography (EEG), positron emission tomography (PET), near-infrared spectroscopy (NIRS), and imaging resonance imaging (MRI) can resolve an active brain condition with a macroscopic solution (e.g., EEG has a millisecond interim resolution and MRI has a localized millimeter resolution) that may experience additional changes in brain volume or excitement experienced within a few weeks of training or Reintegration [9]. In this review we will describe how robotics can help in neuro Reintegration of neurodegenerative disorders – amyotrophic lateral sclerosis (ALS), Alzheimer's disorder (AD), and Parkinson's disorder (PD)

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II. ALZHEIMER'S DISORDER

Alzheimer's disorder (AD) is a predominant cause of dementia. There is no prescriptive drug that will help to stop the flow of emotions, though their effects can be truncated. There are currently no specific symptoms that could confirm a 100% accurate diagnosis of AD.

Alzheimer's disorder (AD) is determined by a progressive decrease in brain function. AD has increased dramatically in people 65 years of age or older, with a progressive deterioration in memory, intelligence, language and learning ability. AD should be distinguished from the general age-related decline in cognitive function, which is slow and associated with minimal disability. Disorders often begin with minor symptoms and end with severe brain damage. People with dementia lose their skills at different rates[10].

Alzheimer's disorder is a progressive degenerative disorder that becomes worse over a span of period, causing difficulties with short term, long term and immediate memory, thinking/ reasoning and social behavior. This can be broken down into three groups: -

In the middle of this stage, the most notable failure is memory damage, which greatly affects temporary memory (difficulty to recall newly learned gospel and retrieve new information). At this stage patient is not able to do is household activities of daily living which becomes more severe in the last and final stage where the affected person is completely dependent on his family. [11].

Robot investigative projects have tried to help patients who are affected with degenerative disorders and caregivers. A latest type of robot is determined: Socially Assistive Robot (SAR.). SAR. is defined by Tapus et al. in 2005 as a merger of Assistive Robotics (AR) which helped in the assistance for ADLs and Socially Interactive Robotic (SIR) which helped in the non-motor disabilities [12].

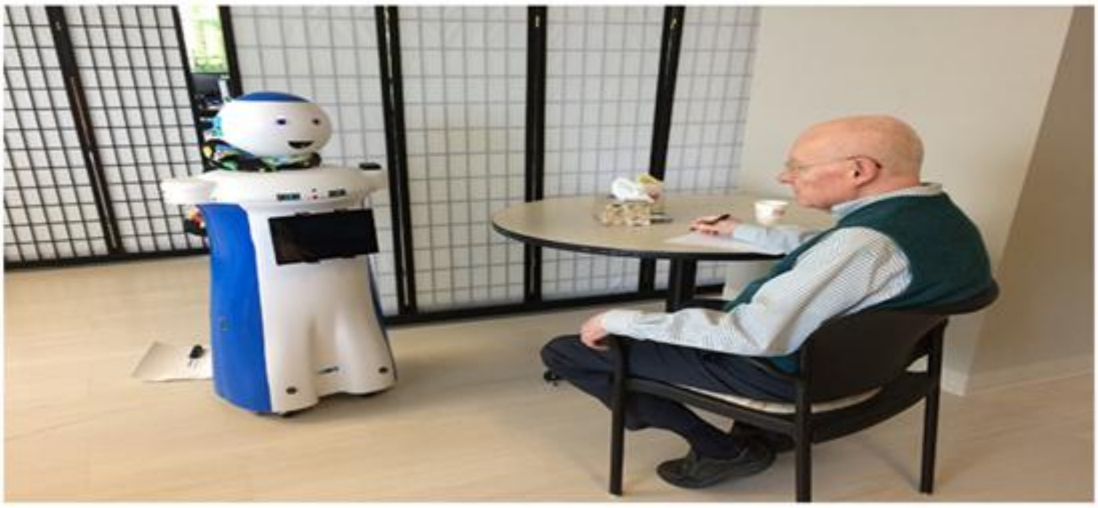

Figure 1: (SAR) Rudy in a pilot study – (Martinez-Martin, E.; Escalona, F.; Cazorla, M. Socially Assistive Robots for Older Adults and People with Autism: An Overview. *Electronics* 2020, *9*, 367. https://doi.org/10.3390/electronics9020367)

SARs are therefore designed to assist disabled human beings by the medium of social media. Treatment plans for patients with dementia (as well as AD) have already been created using SARs.[6,7] According to earlier research, using a biomimetic robotic system, some customers have consciously enhanced their capacity for sustained attention, cortical function, and regulation of emotions including despair and anxiety. Additionally, patients needed some administration while speaking with the robot, which reduced stress in their families as a result.13].

Numerous experts are looking into how robots and senior citizens interact. Additionally, some elderly individuals have devoted attention to proper look or the image of an adult-communicating robot. According on the appearance or representation of robots, UWu et al. investigated how elderly individuals identify robots. People talked about their initial ideas about robots at the beginning of the research. After that, a presentation of 26 (twenty-six) various robotic imagery was shown to the audience, coupled with a brief movie of moving robots. Finally, each person selected their top three robots [14]. The findings demonstrated that people frequently selected little and miniature robots with human or animal traits.

Some scholars have examined how robots might assist the elderly as this trend continues. Mast et al. used a variety of questionnaires, created for authors, to conduct study on the effectiveness of twenty-five (25) robotic services that were accompanied by descriptions or images. Seniors and their caretakers from Italy, Germany, and Spain participated in the survey. Older people choose difficult housework, emergency or critical care, and travel-related activities as the best services. Social, collaborative, and emotional services, in contrast, received lower ratings. In order to understand SAR performance in adults, it is important to include the perspectives of both the elderly and their caretakers, according to different results between the two groups [15].

Robotic applications for adults with mental retardation. We focus on robots used in patients with certain mental disorders (including AD patients). These types of robots focus on such things as social interaction in the form of touch, cognitive aid and physical and mental stimulus. In the case with Paro, a baby robot made in Japan. Its main purpose is to reduce the stress levels for patients, to encourage their participation and to boost up their enthusiasm [16]. Paro's robots have been tested with adults with dementia and outside many facilities. Many patients have shown reduction in their levels of stress and interactions not only with their caregivers but also between themselves.

In addition, the caregivers also feel reduction in their anxiety levels as patients require little attention while working with a robot. Another newly developed robot is named Babyloid, a baby robot is assembled to care for a patient suffering dementia. Its purpose is to decrease stress and upsurge the patient's enthusiasm, giving us the important role of caring for the "child" but without the risk involving the real child. In this scenario, the whole idea is to make use "the doll therapy" because it has been researched and proven to enhance the mood of patients.

Other assistive technology, on the other hand, are made to be utilized at home. This method, which combines a mobile robot with intelligent intelligence, was first used in the Com123 88 Int J project by Soc Robotic (2016) 8: 85-102 panionAble. In this study project, a robot named Hector provides a range of services, including psychological training, video calls for socializing, and individual agendas.[17].

Figure 2: Babyloid robot http://bit.ly/fMfa2C

Other responsibilities of a smart home include monitoring a user's activities at home or detecting a patient who is at danger of falling. As a result, not only did those who had dementia benefit, but also their partners who were also caring for them, which relieved some of their burden. There are also a lot of research using commercial robots that are utilized in this policy but aren't made expressly for adult communication. This is the account of a piece of work that Kanamori et al. presented in which they applied "animal treatment" to the robotic dog Aibo. After repeated home visits, they discovered that the elderly's tension and loneliness had decreased. The authors came to the conclusion that because Aibo was not intended for therapeutic use, communication was not sufficiently promoted, necessitating further therapeutic treatments.

However, Martn et al. employ the Nao robot, a humanoid trade tool with a common application, as a technique to encourage comprehension in the care of psychiatric patients. Nao contributes, for instance, to physical therapy by making motions that patients can directly imitate since she has personality. In this instance, therapists took control and developed the treatment sessions. Describe the interaction between robots, music, and movement. Their preliminary findings revealed that, in comparison to the outcomes attained using conventional approaches, several of the patients' symptoms were much improved. Many of these events concentrate on a single facet of support; others emphasize active participation, which changes the way it is structured and operates. Some people prioritize completing duties, like exercising or setting reminders for daily activities, but they have a tough and cold exterior. The majority of them attend to the demands of the patients in their design, but not those of the carers, who struggle with enormous workloads and lack of free time[18]. In a research by Broadbent, trained caregivers were surveyed and interrogated about the various tasks carried out by a robot in a senior community. The findings demonstrated the obvious differences in possibilities between citizens and workers. The RobAlz project is unique from earlier efforts in two key areas. To begin with, we take the same route as Broadbent but rely on a new team of professionals from the beginning of the project.

The introduction of a real robot that will live with AD patients in their homes or in nursing homes would not be possible without their comprehension. In order to meet the demands of both patients and caregivers, it also strives to offer a variety of services and terms of usage. The objective is to make the construction of the various robots in the group simpler rather than to clarify the list of SAR hermetic functions. As a result, robotic researchers who want to develop a robot that would assist dementia patients and their caregivers don't have to accomplish it right away because there are other frameworks, such working conditions and common variables, that they may take into account while designing their robots. [19].

III. PARKINSON'S DISORDER

After Alzheimer's disease, Parkinson's disorder is the most prevalent neurodegenerative condition, with an estimated dose of 20/100,000 and a rise of 150/100,000. The loss of dopaminergic neurons in the substantia nigra of the midbrain is the cause of common clinical symptoms. A portion of the neurons that are still alive contain Lewy's body. The concept that these disorders may have some shared pathogenetic processes has been supported by the clinical relationship between Alzheimer's disease and other neurodegenerative disorders. [20].

Various studies have been performed on robotics in Parkinson's disorder

Patients with Parkinson's disease (PD) have been shown to benefit from treadmill training (with or without a robot's assistance). However, individuals with mild to severe PD (Hoehn and Yahr class part3) were primarily used to examine its effectiveness in post-test stability. With their feet placed at the feet of the drivers, patients with significant ailments can benefit from robotically aided training with the Gait-Trainer GT1. The purpose of this study was to determine whether robotic-assisted training could improve the postoperative posture of patients with Parkinson's disease in Hoehn and Yahr section 3–4. [21]

A robotic walker that is active and helped by people who have Parkinson's disease. Many PD patients experience abnormal levels in addition to losing their balance. These symptoms frequently make PD patients clumsy and diminish their quality of life. They study PD patients' tendencies using the Hidden Markov Model (HMM), and when abnormal behaviors are identified, they assist patients in returning to normal performance while wearing hearing aids by using our walker. The walker locks the engines when the user unexpectedly discovers them, preventing the user from stooping before dropping to the ground. Additionally, the walker can record the user's gait information, which helps therapists better understand the healing processEventually, the user will be able to modify his speed based on the current state of the road in front of him. To our knowledge, the robotic walker that is being developed would be the first system that could provide PD sufferers mobility. In this study, PD patients at two levels of adult treatment rated the program's performance and effectiveness. [22].

The purpose of this study was to compare the effectiveness of robotic-assisted training (RAGT) and the general exercise program (CEP) to traditional gait training in terms of improving the perception of PD. Methods: The experimental group (EG) or control group was randomly assigned to 38 patients with low PD (H&Y 2-2.5). Both groups received 30 minutes of CEP. Nineteen patients in the EG underwent RAGT for 30 minutes (using the Lokomat device), while nineteen controllers received normal training. The 10-MWT, Tinetti evaluate, and UPDRS-III vehicle were used to evaluate participants before (T0), immediately after (T1), and 12 weeks after the conclusion of treatment (T2). Mobility and vehicle performance can both be considerably increased by RAGT for up to three months. As a result, their data confirm that RAGT is a useful method for PD23 renewal. a robotic walker that is active and helped by people who have Parkinson's disease. Most PD patients experience aberrant measures in addition to losing their balance

Figure 3. Robot-assisted gait trainer. Lyra (Thera Trainer, Hochdorf, Germany) (left); Lokomat (Hocoma, Volketswil, Switzerland) (right). Schicketmueller, A.; Lamprecht, J.; Hofmann, M.; Sailer, M.; Rose, G. Gait Event Detection for Stroke Patients during Robot-Assisted Gait Training. *Sensors* 2020, *20*, 3399. https://doi.org/10.3390/s20123399

These symptoms frequently make PD patients clumsy and diminish their quality of life. They study PD patients' tendencies using the Hidden Markov Model (HMM), and when abnormal behaviors are identified, they assist patients in returning to normal performance while wearing hearing aids by using our walker. When the user abruptly detects the walker, it locks the motors to prevent the user from stooping before dropping to the ground. Additionally, the walker can record the user's gait information, which helps therapists better understand the healing process. Finally, the user will be able to modify their speed as the road conditions in front of them are immediately updated. To our knowledge, the active robotic walker that is being developed will be the first system that can help Parkinson's disease patients move around. In this study, PD patients at two levels of adult treatment rated the program's performance and effectiveness. [22].

The purpose of this study was to compare the effectiveness of robotic aided training (RAGT) and the general exercise program (CEP) to traditional gait training in terms of improving the perception of PD. Methods: The study group (EG) or the control group (CG) were randomly allocated to 38 patients with low PD (H&Y 2-2.5). While 19 controllers received conventional training, 19 patients in the EG underwent 30 minutes of RAGT (using the Lokomat device), and both groups underwent 30 minutes of CEP. The 10-MWT, Tinetti evaluate, and UPDRS-III vehicle were used to evaluate participants before (T0), immediately after (T1), and 12 weeks after the conclusion of therapy (T2). RAGT has the potential to greatly enhance mobility, motor performance, and three months. Thus, their findings are consistent with the value of RAGT as a valid outcome measure for updating PD[23].

IV. AMYOTROPHIC LATERAL SCLEROSIS DISORDER

It is thought that ALS is a complicated condition that is passed to a person by a combination of genetic and environmental factors.1, apoptosis, inflammation, and excitotoxicity. However, the precise reason is uncertain in the majority of patients[24].
Robotic testing is typically used on ALS patients. Sensorimotor dysfunction is typical among ALS patients, but some also exhibit significant mental retardation. [25].
Work-based training with visible computer response and aerobic9 exercise that is both difficult and repetitively performed may be associated to the beneficial effects of robotic reintegration on patient outcomes. During training, a visual response tool is employed to boost patient motivation, involvement, and vehicle mobility. Given that robotic resuscitation may improve neural connections and reduce neuronal atrophy in the brain and spinal cord as well as muscle strength and endurance (via quantifiable aerobic training), it is fair to anticipate that it will also be effective in ALS patients.

Randomized clinical trials are required to determine whether robotic therapy can slow the progression of ALS patients' disorders and enhance their quality of life.[26].

V. CONCLUSION

Robotics can assist in the precise diagnosis and monitoring of neurodegenerative disorders by providing quantitative and objective measurements of patients' motor skills, tremors, and other symptoms. This data helps clinicians track disorder progression more accurately. Robotic devices can provide objective assessments of patients' motor function and cognitive abilities, reducing the potential for subjective bias in evaluations. This is particularly important for monitoring disorder progression and assessing the effectiveness of treatments. Robotic devices can be used for therapeutic interventions such as physical therapy and Reintegration . They offer controlled and repeatable movements, which can help patients regain or maintain motor skills and coordination. Robotics can adapt to individual patients' needs and abilities, providing tailored therapy sessions. This personalization can lead to more effective and efficient Reintegration outcomes. For patients with mobility challenges, robotics can enable remote monitoring and telemedicine. Patients can perform therapeutic exercises under the guidance of healthcare professionals without needing to travel to a clinic. Robotic devices can facilitate motor learning and neuroplasticity by providing patients with repetitive and challenging exercises that encourage the brain to rewire itself. This can help patients learn new motor skills or compensate for lost functions. As neurodegenerative disorders often require long-term care, robotic devices can ease the burden on caregivers and healthcare facilities. Patients can perform exercises at home with guidance from robotic systems, reducing the need for frequent clinic visits. Interactive and gamified robotic exercises can make Reintegration more engaging and enjoyable for patients, increasing their motivation to participate in therapy sessions. Robotic systems can collect longitudinal data on patients' progress over time. This information is valuable for understanding disorder trajectories and optimizing treatment strategies. Robotic platforms provide researchers with standardized tools for studying neurodegenerative disorders and analyzing large datasets. This can lead to insights into disorder mechanisms and the development of novel treatments. For conditions like Parkinson's disorder that increase the risk of falls, robotics can offer balance training and assistive devices that help reduce the likelihood of accidents. In cases where neurosurgery is necessary, robotics can aid surgeons in performing delicate procedures with higher precision and reduced invasiveness. It's important to note that while robotics offers many benefits, its integration into the management of neurodegenerative disorders requires careful consideration of patient preferences, safety concerns, and individual disorder characteristics. Collaboration between medical professionals, engineers, and researchers is crucial to developing and implementing effective robotic solutions that improve the quality of life for individuals with these conditions. Overall, medical AI has the potential to revolutionize healthcare by improving diagnostic accuracy, speeding up processes, reducing costs, and ultimately enhancing patient outcomes. However, its successful integration requires careful validation, ongoing monitoring, and collaboration between medical professionals and AI experts. Despite its potential benefits, medical AI also raises ethical and regulatory challenges. Ensuring patient privacy, maintaining the quality and accuracy of AI algorithms, and establishing clear guidelines for clinical decision-making are all important considerations. To conclude robotics is future mandate for Reintegration as it is giving promising results in neurodegenerative disorders along with other manual therapies. More research is required to explore these disorders and play part in improving the quality of life of disorder individual.

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