Technological Advancement to Neurorehabilitation

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Abstract

Neurorehabilitation defines an appropriate treatment process for individuals who are suffering from various kinds of neurological disorders. Neurological disorders are complex problems related to the brain of humans. Accordingly, it affects the nerves of the brain and also the nervous system. This article is based on the neurorehabilitation process and it has discussed the technological advancement of neurorehabilitation. This study explains about different types of technologies and their processes and practices. In the modern era, robotics, Non-invasive stimulation of the brain, Neural interfaces, Exoskeletons, and virtual reality. Accordingly, from this study, it has been seen that radio frequencies are tracked with different kinds of GPS devices that are beneficial for determining growth. In addition, Intraoperative computed tomography (ICT) is the technique that is most beneficial for advanced medical imaging for developing the accuracy and safety of the placement of the electrodes in the brain. This study used a secondary qualitative method and it put the effective impact on the study material and further progress. This process helps to gain extraordinary knowledge and information for the study and it also allows to development of the standard of the study. From this study, it has been recognized that there are different kinds of wearable monitors that assist to understand the problems of rehabilitation programs for and mobility and estimating physical activities. In this context, different neurodiagnostic technologies are improved to ensure the growth of the brain and nervous system and its disorder issues.

Keywords

Brain, Exoskeletons, GPS devices, ICT, nervous system, Neurological disorders

INTRODUCTION

The term neurorehabilitation can be defined as a proper treatment process for individuals who have been suffering from neurological disorders. Neurological disorders are one kind of complicated issue related to the brain of a human, which affects the nerves of the brain. Apart from that, some severe neurological issues can also affect the networking system of nerves and the spinal cord. The reasons for emerging neurological disorders can be predicted by genetic issues, spinal injury, congenital disease, and inappropriate lifestyle. Some neurological disorders are common and recognized as psychiatric illnesses. In this regard, it can be observed that the drug market of neurological disorders in the US valued at 20 billion US dollars by the year 2019.

The process of neurorehabilitation should be applied to the patients who have received severe brain or spinal cord injuries. The formation of disabilities can shatter the lifestyles of the patients and also their families. Neurorehabilitation promotes the improvement of the quality of living of those patients after coming up with the situation. In that case, patients must not compromise with their way of living due to some sudden injuries. The neurorehabilitation process is one of the most complicated care approaches for the patients because it requires skills and knowledge. Apart from that technological advancement has brought the process quicker in comparison with the previous technical methods of Neurorehabilitation. Before applying any specific care approach to the patients, it is necessary to focus on the independent behaviour and well-being of the patient. The methods of Neurorehabilitation include multiple therapies such as physiotherapy, psychological therapy, medication, communication therapy and swallow therapy. However, it can be further observed that, after the merger of science and technologies, images of the Human Brain can be taken easily with the help of neuroimaging. The study will further shed light on the critical advancement of science and technologies on the Neurorehabilitation process. On the other hand, further utilization of robotics can provide the entire process a cutting-edge development along with the patient-centered approach.

LITERATURE REVIEW

Types of technologies used in the neurorehabilitation process

The rapid enhancement of technologies can be considered as a blessing for treating neurological disorders. Medical practitioners keep applying these technologies in their daily treatment practices. The advancement of tools is only possible with the help of IT and communication processes. In that case, the alternation of therapies for neurological disorders can be further denoted as the conventional therapy, which can be known as the "Robotics therapy process". Within this process, the central system has been reacting synchronously after aligning them with technological equipment. These technologies can easily produce short signals, faster processes, and clear image quality of different parts of the brain.

In order to achieve proper administrative approaches, the field of neuro-engineering has developed robots or some wearable devices which can work with "invasive brain

stimulation". One of the fundamental purposes of the implementation of Robotics in the neurorehabilitation process is to promote the recovery of the Neuromotor system since 1990. On the other hand, there are various kinds of rehabilitation technologies that make a huge impact on the healthcare system.

Robotics: robotics therapy allows the high control, intensive and repetitive training that is able to decrease the physical burden for physiotherapists and it also provides the modern facilities to the patients to grow their progress through the process of rehabilitation. This process uses the gait rehabilitation robot and it helps to develop the LOKOMAT.

Figure 1: Robotics in neurorehabilitation
Source: [1]

There are different kinds of robots that help to provide healthy life and well-being to patients [1]. Accordingly, neurorehabilitation robots are designed to support the entire administration of the physical exercise to the lower and upper extremities. It also participates to promote neuro motor recovery and it has a long history of invention and implementation processes.

Non-invasive stimulation of the brain:

The brain is the dynamic organism of the body that is able to catch the external and internal changes of the environment. In the current year, it has been seen that neuroscience has achieved a good understanding of the mechanism of the process of neural plasticity [2].
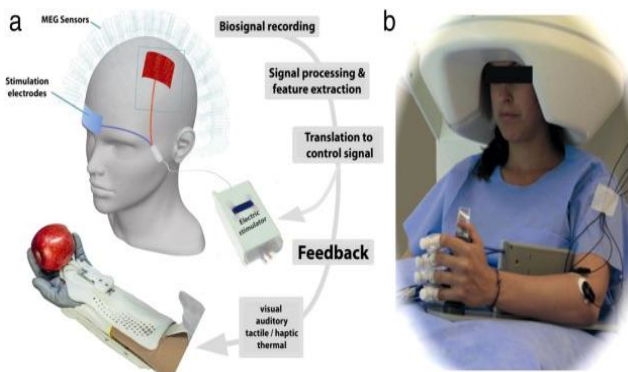

Figure 2: Non-invasive stimulation of the brain
Source: [2]

TMS or transcranial magnetic stimulation and electric brain stimulation are all the non-invasive techniques that support modulating the neural changes. It is one of the painless and safe ways of treatment. The professionals can combine the other techniques and processes with the other kinds of techniques to increase the effectiveness and improve the treatment process as well.

Exoskeletons:

Portable Exoskeletons are the revolutionary devices for gait rehabilitation. It is able to promote physical activity and those devices help to provide flexibility to the patients. On the other hand, Exoskeletons are wearable systems that are able to consist of the electric motors, mechanical structures, sensors, batteries, and computers.

Figure 3: Exoskeletons
Source: [3]

In this context, it can be said that the operating principles of exoskeleton for the gait rehabilitation depend on the information that is captured by the sensor and advanced types of algorithms [3]. In this case, a computer is able to detect the intentions of the users to take an action. On the other hand after detection, the computer plans for the movements that the exoskeleton must carry out to take the action and helps to send the information to the motors that are responsible for executing the movement in synergy with the patient or user.

Virtual reality:

Virtual reality is an essential cutting-edge tool that can able to assess the virtual scene that can be used for the motor rehabilitation. Accordingly, virtual reality devices are able to detect the orientations of the users with a high range of precision. In addition, in health science, virtual reality is one of the innovative fields and the transnational research is applied in the clinical practices. It helps to recover patents and this opportunity helps to provide the professional to increase the opportunity in the medical field.

Neural interfaces:

Neural interfaces are the greatest engineering solutions that are able to restore the connections of the brain. It also allows the body to reconnect and provides the provision for the recovery of the people. It generally promotes the recovery of people and it depends on the fact that the human neural system processes and transmits electrochemical signals that can be stimulated and interpreted.

Advantages of technology in neurorehabilitation

There are various kinds of advantages of neurorehabilitation technologies in health care. From this study, it has been seen that health professionals use these technologies to recognize the disease and issues of the brain and nervous system. It is an easier process than others and it makes a positive impact on neurological science. This kind of technology assists to recognise the issues and also being able to catch the frequencies of the brain and also find the position of nerves and cells. Technological advancements are quite easy than other manual methods and technology can give access to recognize the faults and difficulties of the nervous system and brain of humans [4]. It has been seen that neurological rehabilitation arises in the '60s and the therapeutic treatment for the patient with spinal cord injury and stroke, that can able to grow severe sequelae. It also affects the patient's sensory and motor abilities.

On the other hand, CNS, or the central nervous system has the plasticity mechanism for the spontaneous recovery process. Accordingly, a high range of patients received some special kinds of therapies to restore motor function, for example, upright physical therapy or *"Constraint Induced Movement Therapy"*. Technological rehabilitation helps to control and restore brain signals and it makes effective support on the recovery of patients. Robotics and computer devices basically designed for producing positive changes in the cortical excitability of the *"cerebral hemisphere"* hampered and also develop neuroplasticity. Electrotherapy apparatus, and devices, are generally used for the "robotic lower limb orthoses","" robots for upper limb training," transcranial magnetic stimulation, and many other things [5]. From the different studies, it has been seen that there are various kinds of controversies regarding the benefits and the application process. It can be stated that the main purpose and aim of neurorehabilitation technologies is taking the benefits of the preserved and functional neuromuscular structures.

Relearn about the damaged area of neurological functions that were made earlier or damaged area. This kind of technology helps to provide the huge advantages of the health professional that they can indicate the actual reason of the neurological disorder and also set the dose of medicines or all. In addition, neurological rehabilitation provides opportunities that assist to the health profession and students to know about the highly sensitive frequencies and signal pathways and it also allows the professionals to create conclusions about their studies and application.

Implementation issues of neurorehabilitation technologies in healthcare

Impairment, disabilities, and handicap issues are the basic principles of neurological rehabilitation technology. The future research tool that is helping to connect the brain with software that is developed with electrodes is beneficial for the spinal pathway. This is developed due to nonfunctional development for trauma or damage growth. Physical, social, and emotional functions are developed that is essential for gaining a good quality of life with the different highest level of functioning and independence possible to gain. The equipment is using to examine the brain and central nervous system (CNS) are included necrobiotic systems, neuroproteins, brain-computer interface, and different wearable devices. The barriers to implementing neurorehabilitation are developing in health. Factors such as logistical, affordability, knowledge, and attitudinal factors are creating different issues for neurorehabilitation process development. Lack of awareness is developed in the people are developed as a barrier for people to gain the proper understanding of technologies in the healthcare process [6]. Rehabilitation programs are developed for ensuring the growth and development of improving fitness, energy management, speech, and cognitive functions. Physical therapy, occupational therapy, cognitive rehabilitation, and speech-language pathology are gained from the rehabilitation process development.

The supports developed for helping people suffering from different issues of maladaptive behaviors are occurring weakened mussels that are created due to prolonged sedentary behavior. Brain health is promoted and the gain best protection is developed from neurological disorders controlling the issues of reduction of neurological dissepiments. A well-balanced social and mental well-being is developed to be ensured as the best way to reduce neurological impairments in the brain. Minimizing and slowing down the process of disability effects for chronic health disorders. The issues of cardiovascular diseases, diabetes, and cancer are such effective diseases that are ensuring the main goals for rehabilitation programs. Different wearable monitors are helping to understand the issues of rehabilitation programs for estimating physical activities and mobility [7]. Different neurodiagnostic technologies are developed to ensure growth for brain and nervous system disorder issues. Electroencephalograms (EEGs) is used to assess brain activities that are beneficial for treating patients for helping growth. The brain-computer interface (BCI) are mostly a popular neurotech product, and the brain-machine interface (BMI) is helping to solve different neurotechnological issues. The diagnosis with neurologists are managing and treating conditions of the brain and spinal cord disorders are creating issues for ensuring health and well-being for people.

Neurotechnology technique and practice

Neurotechnology refers to all the technologies that can able to check the brain and its functions. Neurotechnology uses various kinds of techniques and practices that can be able to record the activity of the brain and stimulate all the parts of the brain. The noninvasive technique allows the action outside of the brain and the invasive technique requires the implantation process of electrodes through surgical procedures. There is various process that can measure the activity of the brain and also provides a visible report.
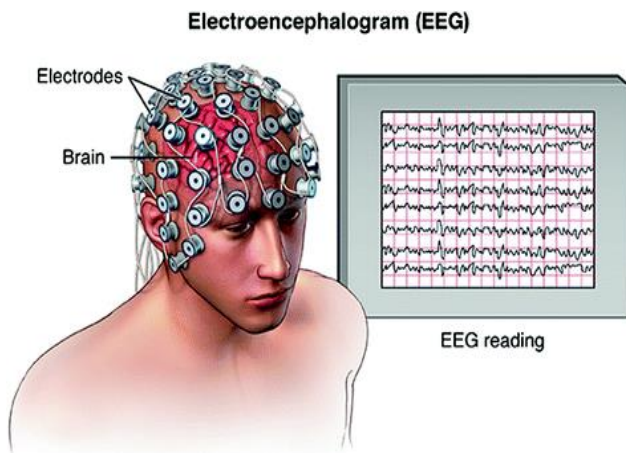
Figure 4: EEG or electroencephalogram
Source: [8]

EEG or electroencephalogram: It can record all types of activity and also measure the frequencies of the brain by using electrodes placed on the scalp [8].

firs or Functional near-infrared spectroscopy: It uses a hand help high-capacity sensor that is also placed on the scalp of the patient. It is always a lower resolution than MRI and it also can detect the major issues in the brain.

fMRI or Functional magnetic resonance imaging: This process can measure the activity of the brain and it also detects the changes in the flow of blood using the high resolution that fMRI.

Implantation of microneedles: This is an invasive technique and it involves the tiny electrode in the cerebral cortex. In this case, the signals are clear and it also reaches a much-limited area.

There are various techniques that can stimulate the brain such as:

DBS or deep brain stimulation: This process can be performed through the surgical implantation of electrode; it can detect the symptoms and other difficulties of brain.

FUS focused ultra sound: This is a non-invasive technology that focuses on the pulse and it also stimulate the particular are of the brain [9]. On the other hand, it also applied on the nose and eye and also provides the solutions of the problems and helps the patient to get fast recovery.

TMS or Transcranial magnetic stimulation: It is based n the magnetic field and also produce the electrical flow in the brain. Accordingly, it also able to communicate between neurons and also improve the learning, perception and memory.

test or Transcranial electrical stimulation: This is another non-invasive technique that applied electrode on the scalp and it also can stimulate the certain function of brain.

METHODOLOGY

This study uses the secondary qualitative process to continue the research method. This process helps to get the accurate result for the study and accordingly the reason for choosing this method in the study, helps to gain more knowledge on the technology and neurorehabilitation as well. In this research study, this method helps a lot and this is a quite simpler process than other methods of data analysis and collection. From the secondary qualitative analysis, the method provides the opportunity to get a variety of knowledge on the subject matter. These kinds of data analysis and collection methods require minimum knowledge of the technical skill. On the other hand, it also helps to choose the relevant data from the study [10]. The main cause of selecting the secondary qualitative process helps to gather and collect lots of data that help to provide a significant path on the study procedures. On the other hand, this study uses the existing data, those are previously used and collected by another person. Accordingly, these data are always available and researchers are able to use the data in other research work. In the secondary qualitative, researchers use various journals, newspapers, thesis papers, and magazines to collect the data. Moreover, this process provides the opportunity to extract the exact data from a large number of data sets. It helps to acquire more knowledge on the topic and it also makes a positive impact on the process of data analysis. Accordingly, it can be said that there are various types of data and all data are not too much relevant to the subject matter of the subject. This data analysis process gives the provision to analyze the data and recognize similar data from the data set.

In addition, it provides a wide resource for data collection that helps to get accurate outcomes from the study. This process does not require too much time to process the examination process which is why this is much time saving and it also has effective effects on the entire study process. In other words, this kind of analysis process gives the chance to save the budget also because data is always available on the internet and it is not required money for collection and use. All the data are authentic or the author is also authentic and this process gives a constructive framework to data. From this study, it has been seen that there are various kinds of issues in neurorehabilitation technology implementation [11]. On the other hand, it has been seen that neurotechnology techniques and practice make a huge impact on the entire healthcare system and it helps to provide accurate outcomes for the patients. Accordingly, it helps to generate the map and ways of the brain signals. That makes a huge impact on the procedures of treatment. This method also provides information about the various kinds of technologies that relate to neurorehabilitation. Accordingly, this process assists to generate a significant conclusion on the research subject matter as well.

DISCUSSION

Neurorehabilitation technologies are developed with different issues that are gained through robotics, exoskeleton, virtual reality, neural interfaces, and monitoring processes are improving growth issues gained through neurorehabilitation technological development. The future research tool that is developed with the brain-machine interface is connected with software that is developed as an

advantage of neurorehabilitation [12]. The field of neuro-oncology is developed as a continuous process that is able to understand different molecular underpinnings of central nervous systems. The classification of tumors especially brain tumors is investigated by new therapeutics. Electroencephalograms (EEGs) is the device to understand the monitoring activities through the skull is important for diagnosing of different seizure disorders that are affecting the brain's activities. The neurological status of patients is monitored with wearable monitoring systems that are important for gaining activities. pedometers, accelerometers, and different multisensory systems are able to understand the physical abilities and monitoring process of neurological status. The rehabilitation therapy is divided in three types these are occupational, speech, and physical, this is beneficial for understanding the growth issues that are helping the patients for gaining a healthy and active lifestyle. Functional magnetic resonance imaging (fMRI) is the most popular MRI technique that is important for understanding the alteration of brain functions. The use of nanotechnologies is helping to ensure future care by altering doctors for giving early signs of cancer, developing different targeted therapies, and ensuring treatment effectiveness, the three major fields of oncology that is radiation oncology, medical oncology, and surgical oncology are not affected by the process [13]. The radio frequencies are tracked with different GPS devices that are beneficial for understanding growth is understood. Intraoperative computed tomography (ICT) is a technique that is beneficial for advanced medical imaging for improving accuracy and safety for the placement of electrodes in the brain are understood. The patients are not affected in the process of surgery they also not to wake during the medical imaging process.

Figure 5: Innovation in neuron rehabilitation
Source: [14]

The mobility of brain process is understood by people with tetraplegia and intelligent prostheses which is beneficial for understanding process of limbs of brain stimulators that are

developing electric current is helping to develop a neuronal activity. Neurorehabilitation process are getting advanced with the research process for gaining growth are developing as an advantage of neuroscience [14]. Magnetic Resonance Imaging (MRI) is the newest form of brain scanning process that is beneficial for creating a 3D detailed anatomical images for the brain. This process is a non-painless process that is also a non-invasive imaging technology. The latest technological development in radiation Stereotactic body radiation therapy (SBRT) this is help to cure different types of cancer that are developing. The monitoring system has developed with four categories that are observation, analysis, storage and action these technological effects are helping to understand the issues of neuro rehabilitation monitoring process. The using of AI (artificial intelligence) is helping to produce an enhanced performance for surgeons, understanding the reduction of errors of neurosurgery. Robotics are growing in a rapid manner that can in the future replace the neurosurgeons for the understanding of different minimal invasive approaches of brain and spine. AI, surgical robots, 3D printing and imaging methods are the most effective technologies that are used in surgeries in modern time. The lack of time, social influence, lack of energy, and lack of skill and resources are developed as a barrier for technological barriers for neurorehabilitation. Neurostimulation technologies are helping different paralyzed people to walk, proving different prosthetic technologies are helping to provide growth are important for gaining progress in the medical system [15]. The deep brain stimulations, photo stimulation, phytopharmacology process, and many more are used as technological advancements for neuroscience growth. The neurogenetically disorders are identified with single gene defects that is beneficial for understanding the social stimulation process.
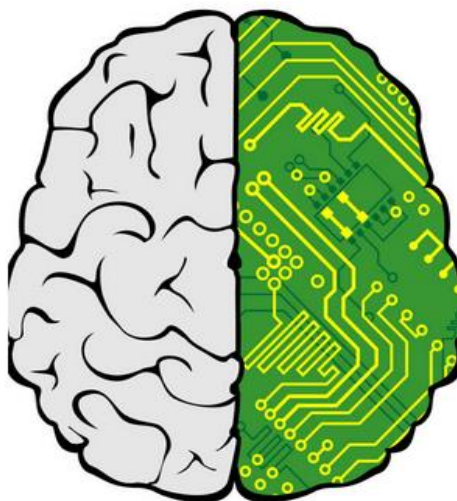
CONCLUSION

This study is based on neurorehabilitation technologies and their advancement. From this study, it has been seen that there are various kinds of technologies that make a huge impact on the entire healthcare system and it helps to recognize the difficulties of the nervous system and brain also. It can be said that this study depends on the various kinds of technologies that can create innovation in the healthcare system. The implementation of these kinds of technologies helps individuals to track their health. On the other hand, it helps the health professional to recognize the issues of the brain and nervous system in a short time. These technologies are much easier than manual diagnosis. Accordingly, technologies are able to provide real-time data to the user. It helps to get the exact result for further treatment. In this context, it has been seen that there are various kinds of issues in the implementation process. It has been observed that hospitals face different kinds of budget issues to implement these kinds of technologies and maintain the technologies. On the other hand, the biggest issue of the neurorehabilitation process is trained staff who are able to

handle the technology and application of these kinds of technologies in their patients. In addition, this technology costs too much that it is not possible to bear for all hospitals. In addition, individuals are not showing a high interest to adapt the new technologies for their health. Nowadays, this kind of concept has been changed and individuals and professionals try to adapt and also try to take advantage of modern technical facilities as well. From this study, it has been seen that there are various kinds of technological categories such as robotics, Non-invasive stimulation of the brain, Neural interfaces, virtual reality, Exoskeletons, and all the process that helps to recover a patient from their difficulties that make a huge impact on the process treatment. Some technologies are able to get the signaling points and a crucial pathway of reflection of reaction. In addition neurorehabilitation technologies also helps to restore the function of the brain and also try o rectify the signals disorders as well. This study has used the secondary qualitative method for this study and also gathered a large amount of authentic data and information for the research paper. This study has explained the authentic and relevant information that helps to provide a concrete structure for the study. At least it can be said that the advancement of neurorehabilitation technology is one of the greatest blessings for the future generation and individuals.

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