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TECHNOLOGICAL REHABILITATION PHILOSOPHY

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Abstract

Technological rehabilitation includes robotic and wearable devices, virtual reality applications, three-dimensional motion analysis systems and e-health and mobile health applications. Our aim was to determine the framework of the philosophy and aims of rehabilitation technology.

These systems have been developed to achieve objective and reliable results, to shape treatment sessions and to improve quality, reduce labor and cost. As the demand for therapy is expected to increase in the future, the technology that will enable patients to receive training with minimal therapist time consumption has an important role. E-health and mobile health systems can be utilized effectively in data generation, storage, transportation, analysis, sharing and security. Robotic devices, on the other hand, are the equipments that come to the forefront in rehabilitation applications with the development of technology. These devices help to make objective, reliable analysis by recording kinetic and kinematic data. Another example of technological rehabilitation is virtual reality (VR) applications. In these systems, by making use of virtual games and visual and audio feedback, it is aimed to get the task and many repetitions as motivated. Finally, optical systems are commonly used in motion analysis and are accepted as the gold standard. They require experienced personnel skills and sufficient laboratory space.

In the studies, it has been concluded that it has made significant contributions in terms of speed, efficiency, accessibility and cost. With such technologies, patients can exercise more often, resulting in better results and faster progress in motor (re) learning.

Although positive results are obtained in the current studies, the development of these systems continues and it is aimed to increase the further studies.

Keywords:

Technology, Innovation, Robotics, Virtual Reality, Rehabilitation, Rehabilitation Philosophy

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Rehabilitation technology is a personalized service that can help individuals overcome the barriers to full participation in education, rehabilitation, employment, transportation, independent living and recreation. This technology includes devices or services that are necessary for individuals to overcome functional limitations (NYSED, 2019). Among these technologies; robotic and wearable devices, virtual reality applications, three-dimensional motion analysis systems and e-health and mobile health applications. Because of the increase in the health care costs of population increase, thoughts such as reducing the frequency of visits to the hospital, benefiting from the experts in a more beneficial way and creating more effective treatment areas with access to statistical information about the disease have enabled the establishment and spread of telemedicine applications (Isik, A. H., & Guler, I., 2010). As the demand for therapy is expected to increase in the future, the technology that will enable patients to receive training with minimal therapist time consumption has an important role (Krebs et al., 2003; Johnson et al., 2005). With such technologies, patients can exercise more often, resulting in better results and faster progress in motor (re) learning (Merians et al., 2002).

The European Commission's Health Commission defined the concept of e-health; “The use of information and communication technologies (network connections, mobile software, robotic applications, smart devices, databases, video conferencing, etc.) in health services and prevention, diagnosis and treatment of diseases, monitoring and management of health (European Commission, 2019).

Mobile technology can be defined as a technology that allows users to access, exchange or communicate data in public and private networks such as the Internet without the use of cables or similar devices without any time and space limitations (Hanayli et al., 2015). Mobile health is defined as supporting health services and applications through mobile technology devices (Guler, E., & Eby, G., 2015). The use of these devices by patients and healthcare personnel is becoming more widespread and enables them to benefit from patient / disease monitoring systems by working in integration with central servers.

These systems are used effectively in the production, storage, transportation, analysis, sharing and security of data (Kilic, T., 2017). MyGlycemia, Glooko and Fizyoprint are examples of mobile applications; e-nabiz and MHRS are web-based applications.

Robotic devices, on the other hand, are the equipments that come to the forefront in rehabilitation applications with the development of technology. These robots are devices for the activation of a limb for sensoriomotor rehabilitation, but also interactive motor devices for potentially cognitive rehabilitation. These systems; It is based on the principle of providing more repeatability with a task-oriented approach and less workload. Some studies show that robotic technology can be used to improve quality and assessment in neurological rehabilitation, increase productivity and reduce costs in this area (Garcia et al., 2011). These devices help to make objective, reliable analysis by recording kinetic and kinematic data (Bertomeu-Motos et al., 2015).

Most of the technological devices applied to rehabilitation are based on advances in neuroscience, which allows us to better understand the phenomenon of brain plasticity underlying the efficacy of rehabilitation (Mehrholz, J., & Pohl, M., 2012).

Regardless of whether they are related to the upper or lower extremities; rehabilitation robots are divided into two groups. Automatic exoskeleton that moves legs by controlling the displacement of each segment, and end-effector devices that allow the mobilization of a limb from a distant application point and control of various joints (Mehrholz, J., & Pohl, M., 2012; Bruni et al., 2018). The definition of an end-effector principle can be defined as simulating the posture and swing phases of the patient's feet on the platform during gait trainings; exoskeleton devices are external robots that can move knees and hips with programmable drives or passive elements. Examples of exoskeleton devices are ''LOPES” (Lower-extremity Powered ExoSkeleton) and ''Lokomat”. Examples of end-effector devices are ''G-EOsystem”, ''Lokohelp”, ''Haptik Walker” and ''Gait Trainer GT1''.

Most robots interact with a virtual environment. The technological complexity of these different systems is quite uneven as it reflects the immature nature of these technologies (Krebs, H. I., & Hogan, N., 2012). The importance of lower limb rehabilitation in hemiplegic patients has been confirmed, and its effectiveness in upper limb rehabilitation is still debated (Hammami et al., 2012).

There are also studies showing that robot-assisted rehabilitation therapy is more effective in upper extremity motor gain than traditional therapy when placed in a complete rehabilitation program (Mehrholz et al., 2012).

In some studies, the "dose" effect is greater than for robot-assisted gait rehabilitation than for robot-assisted upper extremity rehabilitation. Paradoxically, these devices generally offer less advanced functions than those used for upper extremity. The interaction with the patient is often based on the parameters defined by the therapists and the application of force to perform the individual's "normal" gait pattern. There are few devices with self-adaptive functions where the machine can adapt to patient performance (Forrester et al., 2013).

The immature nature of the technology is largely limited by the price of the devices and the reluctance of therapists and patients to use them (Reinkensmeyer, D. J., & Boninger, M. L., 2012). These reluctance feeds on the fear of rehabilitation robots replacing human assistance; however, most studies have shown that the effectiveness of robot-assisted rehabilitation is based on integration into a global program of rehabilitation therapists (Laffont et al., 2014). Considering the limitations of the studies, it is observed that there is a need for comprehensive studies with more cases and a common procedure.

Another example of technological rehabilitation is virtual reality applications. Virtual reality includes different technologies such as sensors, telecommunication technologies, human computer interfaces, and private server or cloud services. These technologies can support precise and detailed capture and analysis of complex kinetic and kinematic variables during motor rehabilitation (i.e., distribution of the center of pressure during standing or walking, time and speed of limb movements) (Lourenco et al., 2018).

Virtual Reality (VR), “a high-end user computer interface that includes real-time simulation and interactions over multiple sensory channels” , should evoke a sense of 'presence' and 'control over' the simulated environment (Kim et al., 2017; Witmer, B. G., & Singer, M. J., 1998). The sense of "presence" consists of the sense of presence in an environment, even if it is not physically present in that environment; the sense of 'overcoming control' includes the possibility of interacting with objects that in this case give a sense of presence in the environment or environment (Corbetta et al., 2015).

The main feature VR provides is the ability to always repeat the same task, changing factors such as the level of complexity, the time and intensity of the application (Lledó et al., 2016). In these systems, by making use of virtual games and visual and audio feedback, it is aimed to have the person perform the task and many repetitions in a motivating way as mentioned.

VR can be used to promote motor learning and rehabilitation as it can be adjusted to produce the environment, scenario or activity that allows motor skills to develop neural plasticity due to motor experience (Doyon, J., & Benali, H., 2015).

Virtual reality systems can be illustrated as follows: Nintendo Wii, Xbox 360 Kinect, CAREN (Computer Assisted Rehabilitation Environment System), IREX (Interactive Rehabilitation and Exercise System) and VR (RE-ACTION) (Ravi et al., 2017).

Finally, optical systems are systems that are often used in motion analysis and are considered the gold standard. The disadvantage of these is that they require experienced personnel skills and sufficient laboratory area. As an alternative to these systems, sensors such as gyroscopes, axelerometers can be used. Thus, it provides advantages both in terms of preventing the place problem and in terms of ease of use (Petraglia et al., 2018).

The rapid development of technology has significantly affected health care as well as in all areas. This development, which manifests itself in many areas from robotic devices to virtual reality systems, is used for many purposes, such as motivating, encouraging, supporting the patient in the process of treating individuals, and performing numerous frequent repetitions. In addition, these systems have emerged to assist clinicians in the work force. There are studies that demonstrate the effectiveness of these systems, but also studies in opposing view. It is thought that studies in specific protocols and in more cases may yield more meaningful results.

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