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Editorial

Precision Rehabilitation 2.0: From One-Size-Fits-All Therapy to Intelligent Personalized Care

Dr. Jaza Rizvi
Ziauddin College of Physical Therapy, Ziauddin University
Karachi, Pakistan

Rehabilitation sciences are in a transition mode where generic treatment models are more and more being replaced by personalized treatment models using technology. Since there are substantial differences in recovery potential, biomechanics, psychosocial status and lifestyle amongst patients, the interventions for rehabilitation have, to a great extent, been standardized in the past 30 years. The increasing integration of Artificial Intelligence (AI), wearable technologies, digital biomarkers, robotics, and the use of big data analytics, however, is changing rehabilitation to a more individualized and adaptive field, called precision rehabilitation[1].

Precision rehabilitation is not simply modifying exercise intensity or frequency according to the patient's tolerance, but maximizing the approach. It is an integrated and evidence-driven treatment model, with ongoing monitoring, predictive analytics and person-specific functional profiling to guide treatment decisions.

Email: jaza.rizvi@zu.edu.pk

Precision rehabilitation, like precision medicine, aims to optimize recovery by using patient-specific physical, behavioral, cognitive, and environmental factors[2].

AI-based systems and wearable sensors have been contributing to this paradigm shift in recent times. Smart wearable devices are now capable of continual monitoring of gait, posture, range of motion, muscle activity, and cardiovascular responses across the real world. For neurological rehabilitation, wearable systems equipped with machine learning algorithms are gaining popularity to evaluate motor recovery, to forecast functional outcomes, and to adapt rehabilitation exercises based on patient performance[3]. The concept of precision rehabilitation has been further reinforced by AI, which allows clinical decision-making to be adaptive. AI-driven rehab platforms can track patient progress in real-time, detect patterns that human healthcare providers cannot, and provide personalized interventions. Additionally, AI-driven rehabilitation aids can help improve adherence, treatment precision, and outcomes, with remote monitoring and tele-rehabilitation models becoming more prevalent, and robotic rehabilitation devices and virtual reality platforms providing increasingly personalized rehabilitation sessions based on the patient's motor functions, cognition, and rehabilitation objectives[4].

One other exciting opportunity for precision rehabilitation is “digital twins” and predictive

recovery models. These systems can simulate the outcomes of rehabilitation using biomechanical, physiological and behavioral data to create virtual representations of patients to optimize treatment. Innovation like this could one day enable doctors to foresee the course of recovery and choose the most effective treatments to improve their chances of success more than ever before[5].

Although promising, there are several hurdles to overcome in order to make precision rehabilitation routine clinical practice. However, high costs, weak technological capabilities, lack of clinician training and data privacy, and algorithmic bias remain as obstacles to broad deployment, especially in low and middle-income countries. Furthermore, too much dependence on technology should not distract from the role of the human touch, empathy, and clinical reasoning in rehabilitation practice.

However, precision rehabilitation is the direction of allied health in the future. The use of intelligent technologies in patient-centred care can help to enhance the effectiveness, accessibility, and responsiveness of rehabilitation. The next generation of rehabilitation practice will be shaped by the ability of rehabilitation professionals to move forward in this rapidly changing environment, innovate using data, while at the same time maintaining the humanistic elements of care.

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