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The use of robotic wearables exoskeleton in managing stroke patients of Pakistan

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EDITORIAL

The global neurorehabilitation arena is presently undergoing a paradigm shift, but the implementation of the developments is at present unevenly distributed across the globe. However, unlike the technological maturity in assistive robotics that has been witnessed in Western countries, where it has attained a level of commercial viability, the developing countries, like Pakistan, have their own hurdles and prospects in their adoption of such life-changing technologies. Stroke is among the leading causes of long-term disability and the second-largest cause of death in all countries, although the ratio of the affected population by the disease is particularly growing in the ageing countries and those countries with sub-optimal emergency care systems.

The introduction of robotic wearables and exoskeletons in Pakistan, where conventional rehabilitation is often compromised by insufficient therapy intensity, work, and cost, presents a key opportunity to increase the functional autonomy and quality of life of survivors. Stroke-related disabilities are high, but there is a disturbing disparity in outcomes. Historically, the contribution of science to the production of assistive robotics in Pakistan has been very minimal compared to some of the biggest contributors, such as Italy and the United States. However, recent local efforts, particularly those done by various institutions, are beginning to close this gap by providing the evidence required on the effectiveness of these technologies in the local clinical environment.(1)

The possible impacts of wearable lower-limb exoskeletons can be significant when applied correctly. The results of the exoskeleton-assisted therapy can be very positive among the post-stroke patients compared to traditional physiotherapy. Specifically, the average increase in the Functional Independence Measure (FIM) might be greater than that of patients receiving traditional treatment. In addition, the Timed Up and Go (TUG) test results of mobility might be poor among the exoskeleton users. They can be translated into a more efficient gait among patients and reduce falls. Notably, the risks of negative events will decrease, thus rendering them safe and well-tolerated devices, meaning that they will not be harmful to the Pakistani population of patients.(2)

The psychosocial aspect of stroke recovery is one of the least discussed aspects. The usual rehabilitation in the context of resource-constrained facilities can be quite boring, which leads to low compliance rates among patients. This is addressed in wearable exoskeletons using gamification and real-time kinematic feedback, which advances the paradigm of human-in-the-loop, which encourages the highest agency of the user. Exoskeleton users can be more motivated, less tired, and more positive about the activities of daily living (ADL). The direct influence of the physical advantage of robotic aid on emotional stability and social integration could be present. This could shift in priorities, in that the focus is not on the biomechanical products but instead on patient-centered outcomes, which is inherent to the circumstances of sustainable recovery in the Pakistani setting.

The other area of the integration of Brain-Computer Interfaces (BCIs) and robots that should be explored is the future of neurorehabilitation in Pakistan. Neural control may have translational opportunities together with external robotic apparatuses. As an outcome in this analysis, the Fugl-Meyer Assessment of the Upper Extremity (FMA-UE) can be applied, and it would benefit the BCI-robot systems, in comparison to their traditional equivalents. The volitional engagement and sensorimotor interaction can be increased to instigate neuroplasticity through the decoding of neural activity to operate an exoskeleton with the aid of BCI. Such hybrid systems can be particularly effective with patients whose impairment is severe, such that they cannot generate voluntary movement, and they can then be rewired to do so at the chronic phase of the healing process.

Robotic Wearable effectiveness lies in the high-intensity and repetitive training and task-specific training, which surpasses the manual capability of an individual therapist. Conventional care therapy may be time consuming inconsistently dosed; exoskeletons, on the contrary, may provide thousands of perfect and symmetrical steps during

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a treatment session. It is a dynamic form of repetitive behavior as one of the key requirements of neuroplastic restructuring of the circuits of the motor systems in the cortex and subcortex. It is by means of these devices that the legs, with the input of proprioceptive information in a way that mimics the patterns set forth by the program, can provide the patient with additional proprioceptive input, re-educate the physiological gait of the patient, and eliminate the dangerous compensatory patterns that ultimately lead to the development of long-term musculoskeletal strains. The active personalization of the treatment can be facilitated by the assistance of this so-called assist-as-needed approach, and its introduction is essential since the functional conditions of the stroke survivors are highly heterogeneous. Challenges to extensive use are tremendous in a country in which robotic wearables are uniquely advantageous in clinical performance. High costs of acquisition and maintenance have always been the key deterring factor, particularly with the more evolved systems like the Lokomat or full immersion VR-exoskeleton hybrids.

Besides, the need to train therapists and institutional investment in technical structures in order to enable the safe and efficient delivery of these therapies is more urgent. It is suggested to address these barriers with the following strategies: First, to offer airer and more affordable telerehabilitation at home, 3D-printed passive or soft robotic exosuits (which are not as costly and bulky) have been invented. Secondly, the process of introducing robotic training into clinical practice is problematic because there is no unified view on what, when, and how long the training is to take place. To optimize the patient selection and dosing, Pakistan needs to adopt standardized and evidence-based procedures, and this may also include the incorporation of proposed ones by the Canadian Stroke Best Practice. Thirdly, ensuring interdisciplinary teamwork across the engineering departments, medical colleges, and policy makers to facilitate the production of goods locally and reform the tendency of relying on imported and costly products.

The transition of experimental prototypes and standard components of clinical care must have a comprehensive perspective on it. It is time that we do not look at the short term impairment measures but rather look more at the long term functional outcome and cost-effectiveness measures. The neurorehabilitation management in Pakistan has a future of strategic implementation of robotic wearables as a complement to competent physiotherapist supervision, as opposed to its alternatives. By implementing these technologies, Pakistan will be capable of turning the rehabilitation into a democratic process, especially in rural or resource-deficient settings where the number of specialists is scarce. The argument is quite strong: robotic-assisted rehabilitation can allow stroke survivors to restore their autonomy and dignity, and it can be safe, efficient, and even revolutionary. The onus is currently on the healthcare leaders and policymakers in Pakistan to devise methods of implementing these innovations to actual solutions that can be sustained to make sure that every citizen who lives with disability is able to enjoy their life fully.

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