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Editorial

Integrating robot-assisted therapy into neurorehabilitation clinical practice: Where are we now? Where are we heading?

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Robot-assisted interventions are developed with the intent of improving the efficacy of neurorehabilitation treatments, supplanting but not replacing clinical rehabilitative practice for patients with motor impairments due to stroke, spinal cord injury, traumatic brain injury, multiple sclerosis, and cerebral palsy. Many technological strides have been made in robotic neurorehabilitation since 1989 when the first MIT-Manus robot was developed. The evolution of robotic-assisted therapy (RAT) and neurorehabilitation itself has changed clinicians' understanding and attitudes towards the use of RAT in neuromotor rehabilitation. The early robots developed in the late '90s were derived from industrial applications and then adapted to rehabilitation. Today, robots are built with novel materials, mechanics, and control strategies that are specifically designed with rehabilitation uses and goals in mind.

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The neuroscientific findings in the fields of motor control, neuroanatomy, and pathophysiology of neurological disorders have increasingly guided the design of rehabilitation robots using precise and personalised approaches tailored to the individual patient's needs. Current commercially available robots are incredibly more useful and effective than those of 30 years ago with substantive enhancements in terms of patient-user interaction, sensory feedback, quality and intensity of motor interventions and detection of patient's movement intention (Grimmer et al., 2019). In addition, robots are also able to perform motor function assessments (Lora-Millan et al., 2022; Toigo et al., 2017). On the other hand, financial affordability still represents a challenging aspect for the next decade.

Current neurorehabilitation approaches emphasize efforts at augmentation and enhancement of neuroplasticity to drive sensorimotor recovery. Therefore, research exploring the optimization of RAT has focused on assessing the determinants of treatment intensity, task specificity, various types of feedback and ever-greater cognitive and sensory integration paradigms alongside the classic determinants focusing on motor control and modulation of spasticity (Morone, Ghanbari et al., 2021). Compared to previous decades, we are now ready for a paradigm shift in the field as related to the use of personalised RAT.

Greater interdisciplinary as well as transdisciplinary engagement between physicians, therapists and bioengineers will help move the field of neurorehabilitation robotics forward. As technological advances continue in robotics design, construction (including miniaturization) and task specificity, accompanied hopefully by greater cost efficiency, we can expect to see further enhancement of our ability to assist those we treat with neurodisability-related motor impairments. As the field of RAT has evolved, it has moved from a dispute about the replacement of therapists by robots, to a dialogue about the progressive and complex integration of robots into the work-area of therapists, thus creating a triangular cooperation and balance between the robot, patient, and therapist.

All clinicians must remember, however, that “not all that glitters is gold”, and although robots are mentioned in several national guidelines regarding stroke care (Morone, Palomba et al., 2021), robot-assisted therapy has, as of yet, not been proven to substantively change neurorehabilitation outcomes. To date, in fact, some clinicians around the world still question the use of robotics in rehabilitation. Possible explanations might be limited effectiveness, high costs, structural efforts, as well as the still existing fear or prejudices robots provoke when used in human work environments. In 2018, in an effort to overcome these problems, the two most representative Italian rehabilitation societies, SIRN (Italian Society of Neurological Rehabilitation) and SIMFER (Italian Society of Physical Medicine and Rehabilitation) proposed a Consensus Conference on the use of robots in neurorehabilitation, named CICERONE (Boldrini et al., 2021).

The present thematic issue entitled “Robot-assisted rehabilitation: technological novelties and clinical proofs” contains eight papers from internationally recognized experts in rehabilitation robotics, mostly from the Consensus Conference, with the aim of offering the readers of NeuroRehabilitation a comprehensive technological and clinical overview of robot-assisted rehabilitation treatments for persons with neurodisabilities.

The review by Cricenti et al. analyzes cognitive outcomes that emerged from all RCTs of robot-assisted arm therapy in stroke. The systematic review by Arienti et al. analyzes the quality of the systematic reviews in robot-assisted arm therapy in stroke rehabilitation. Duret et al. provide a narrative review outlining the principles of RAT for the rehabilitation of post-stroke upper limb paresis and propose a paradigm to promote both motor and functional recovery. The evidence-based improvement of gait in post-stroke patients following robot-assisted training is presented in the systematic review by Mazzucchelli et al., the effects of gait robot-assisted rehabilitation in persons with SCI are addressed in the scoping review by Stampacchia et al., and the implications for clinical practice of robot-assisted gait training in patients with Parkinson’s disease are discussed in the systematic review by Andrenelli et al.

The review by Saviola et al. presents recommendations for applying robot-assisted rehabilitation in pediatric neurodisabilities. Finally, the scoping review by Turolla et al. focuses on reference theories and future perspectives on robot-assisted rehabilitation in persons with neurological impairment.

Starting from the remarkable progress which has been made in the last two decades in terms of robotics technology and concurrent research as well as clinical experience in robotics neurorehabilitation, the challenges of the next decade for a precision-driven, personalised application of RAT can be achieved through increased collaboration among all stakeholders.

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