

EDITORIAL

Recent advances in neurorehabilitation

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The Global Burden of Disease Study in 2021¹ estimated that three billion people worldwide are living with the consequences of a neurological condition. Neurological diseases are the leading causes of ill health and disability worldwide with over 80% of these in low- and middle-income countries. Among the most important conditions causing disability are stroke, neonatal brain injury, dementia, epilepsy and diabetic neuropathy. While major advances have been made in treating acute neurological diseases such as stroke by using treatments like intravenous thrombolysis and intra-arterial clot extraction, it remains the case that only about 10% of stroke patients recover fully, with nearly three quarters surviving with disability. The majority of neurological diseases are incurable with many of them being progressive. Most of these people, however, are likely to benefit from neuro-rehabilitation. Thus, the worldwide need for rehabilitation is huge with potential benefits for the patients, their families and society as a whole. Yet investment into rehabilitation is dwarfed by spending on diseases such as cancer and cardiac disease both clinically and in terms of investment in research. Neurology research is estimated to receive less than 10% of the funding given to cancer research² and much of this neurology funding goes to acute care rather than rehabilitation. This edition of *Advanced Neurology* is focussing on this critical health issue.

Neurorehabilitation has advanced rapidly with the better understanding of neuroplasticity and the networks of neuron and synapses (Heksors). These networks adapt continuously, and neurorehabilitation aims to repair or reshape them after injury—lifelong plasticity.³ Neuromodulation technologies, such as transcranial magnetic stimulation (TMS), Transcranial direct current stimulation (tDCS) and spinal stimulation have been used for decades to excite neurons, and facilitate synaptic plasticity and cortical reorganization. New technology, such as virtual reality, robotics and brain computer interfaces are designed to create sensorimotor integration, feedback loops and motor learning, aiming to amplify the brain's capacity to reorganize after injury.⁴

These advanced technologies offer potentially life changing benefits for some patients but for the majority the most important 'technology' remains the expertise and commitment of the team of therapists working collaboratively with the patient and their family. As an example, despite the advances in acute stroke treatment the most effective intervention for a population of stroke patients is management on a stroke unit.⁵ The most effective component of the stroke unit is the multidisciplinary team working, that when delivered effectively reduces mortality and long term disability in a highly cost effective way. How therapists work, what techniques they use, what intensity of treatment they provide, when during the course of the illness they treat and how services are organised are all important areas that require more research.

Rehabilitation research is very challenging. Compared to randomised drug trials where it is relatively easy to standardise the delivery and dose, to blind patients and researchers to the treatment being given and to collect unbiased outcomes, rehabilitation

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trials are fraught with difficulties. Further, many patients with neurological disease requiring rehabilitation have extensive comorbidities, have progressive disease and are often elderly which again complicates the delivery and evaluation of treatments. Some stroke trials have been conducted, producing results that have had a major influence on patient management. Early supported discharge is more effective than longer-term rehabilitation in hospitals, higher intensity of physiotherapy is more effective than lower doses, intensive upper limb rehabilitation can improve function and the AVERT trial showed that mobilising too early after an acute ischaemic event can be harmful.⁶ New ways of researching complex interventions are needed where conventional randomised controlled trials are not practicable.

One size does clearly not fit all, and neurorehabilitation should be at the forefront of the development of personalised medicine. But when resources are limited, it is understandable when treatment is provided to large groups simultaneously rather than on a one-to-one basis. Whether group therapy is as effective as one-to-one treatment needs to be evaluated. It may be that using robotics and telerehabilitation may provide at least a partial solution to shortages of rehabilitation staff. Certainly, telerehabilitation came to the fore during the COVID pandemic, and there have been several studies showing it to be an effective way of delivering care. But could its use be expanded and can it be used effectively in low- and middle-income countries using mobile phones?

Traditionally, neurorehabilitation was primarily focused on physical disability. Cognitive rehabilitation has been challenging. Cognitive rehabilitation needs can vary significantly due to lesion location, nature of the damage and premorbid function. This makes standardized cognitive neurorehabilitation difficult and complicates clinical trials. There are many unanswered questions, such as when to start, how intensive to be and how long to continue. With advanced technology, such as virtual reality, telerehabilitation, AI and brain computer interfaces, it becomes possible to deliver highly engaged, home-based, personalised cognitive rehabilitation. However, there are still many barriers: limited access, high costs and lack of highly trained staff. More importantly, current cognitive rehabilitation does not always translate into meaningful functional benefit, like employment and independent living. Therefore, further studies are warranted.

Neurorehabilitation with and without advanced technologies can deliver results that can produce

improved outcomes. What is now needed is to persuade young researchers that this is an area that is exciting and potentially life-changing for huge numbers of patients, and therefore worth specialising in. Organisations funding research need to understand the difficulties of conducting neurorehabilitation research while recognising the importance of getting answers to some of the basic problems that many patients and their families experience.

We look forward to receiving your articles for publication in this special edition and are happy to consider primary research in basic sciences and clinical medicine, innovative case reports and reviews of current literature.

Conflict of interest

Both Anthony George Rudd and Liquan Zhang serve the Editorial Board of this journal, but were not in any way involved in the editorial and peer-review process conducted for this paper, directly or indirectly. The authors declare they have no competing interests

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