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Guest Editorial

# NeuroRehabilitation: New concepts in stroke rehabilitation

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Stroke rehabilitation is at a crossroads. I say this because, despite our efforts to leverage the last three decades of basic science research that has revealed the critical link between neuroplasticity and motor recovery through targeted repetitive task practice, we have yet to see any clear impact on clinical outcomes. This is in contrast to acute care where we have seen remarkable improvements in function and survival with the use of intravascular thrombectomy with or without tissue plasminogen activator. Certainly, the EXCITE trial published in 2006 suggested that targeted intensive hand practice improves motor performance, but that was compared to no therapy (Wolf et al., 2006). Subsequent studies that have compared different approaches to therapy for hemiplegic upper limb have failed to reveal a superior method (Lo et al., 2010; Winstein et al., 2016). It is clear that therapy is better than no therapy, but it seems any style of therapy will work as well as any other. This realization, along with evidence of a fixed proportional recovery in hemiplegic upper limb over the first 90 days (Prabhakaran et al., 2008), suggests that various therapeutic exercises after stroke do facilitate recovery of functional ability, but only up to a fixed capacity of neurological performance driven by injury induced biological mechanisms. Whether this capacity to perform matches pre-morbid function, or whether major compensatory strategies characterize performance, seems to be beyond our control. So, where do we go from here?

I am hopeful you will find some useful suggestions in the pages of this special issue of NeuroRehabilitation titled simply "New Concepts in Stroke Rehabilitation". Admittedly, many of the concepts are not new. For example, following the EXCITE Trial there was a focus on specifically training the impaired upper limb and excluding engagement of the intact arm and hand. Here we suggest that perhaps the benefit of bimanual training has been underestimated. Other concepts are more novel in that they challenge our current stroke rehabilitation paradigm by focusing on non-task oriented movement exploration rather than functional task practice.

This issue also contains some thoughtful discussion on biomarkers of recovery in stroke including for aphasia. Potential clinical biomarkers in stroke recovery include baseline motor impairment, neuroimaging, genetic phenotyping and other neurophysiological markers such as induction of a motor evoked response by single-pulse transcranial magnetic stimulation over injured hemisphere. The development of predictive models of recovery using big data is a key avenue to the development of treatment paradigms customized to patient needs and potential. The identification of biomarkers to help direct clinical treatment is new in stroke rehabilitation, and an important area of research. I personally envision a day when every clinical trial in stroke recovery includes secondary aims to identify

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biomarkers predicting response to treatment. Cancer treatment trials have done this for decades. Perhaps it is time we did the same.

Included in this special issue are new technologies including robotics, virtual reality, and brain machine interface. Many devices using these technologies are already available for clinical use, although their penetration into care remains limited due to cost, questionable superiority over standard care and the comfort of therapists with the use of novel technology (Langan, Subryan, Nwogu, & Cavuoto, 2017). Future clinical research will certainly clarify the utility and benefit of these newer technologies. As novel devices enter the clinical environment, it is unlikely that any will separate the patient from the therapist. Rather, smart devices might actually extend the therapists options for applying both standard and innovative therapies. Furthermore, there is a great potential to serve more patients by including new technology as part of a well thought out therapy program and to carryover therapy into the home using gaming technology, robotic assistive devices and telemedicine.

The chapters that follow are written by leaders in the field who continue to investigate deeply the physiology of recovery and the use of biologically based therapeutic interventions. Contained in their writing are insights, some theoretical and some practical, that provide a vision of the steps necessary to push beyond merely compensatory training in stroke rehabilitation and onto a level of recovery that is satisfactory for our patients.

I was pleased to see that these steps include consideration of a truly patient centered approach, focusing not only mutually agreed upon goals informed by biologically determined recovery potential, but that also integrates an individual's personal values, cultural origin, family support and living environment. It is important to recognize these aspects in the process of recovery and rehabilitation in order to assure carryover of functional performance from clinic to home, and from home to community.

As we stand at this crossroad, the direction we need to take is becoming more clear. Be open to new approaches to care beyond task oriented training. Utilize new technology in order to extend therapeutic approaches beyond the mat, treadmill and hi-lo table. Critique new research based on whether it suggests just another form of compensatory training versus expansion of functional capacity. Consider the incorporation of biomarkers into clinical research and bedside care. We know where we need to go. I hope then that we can successfully negotiate the pathways that push beyond merely 70% recovery.

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