



Neurotechnology Innovation Network

Biodesign workshop series episode 3: Stroke rehabilitation
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Stroke rehabilitation – Needs identification

Stroke is the main cause of disability in adults. Recovery from the neurological damage of a stroke is predicated on the adaptive capacity of the central nervous system. This neuroplastic process can be enhanced through intensive task specific practice, stimulating environments, cognitive engagement and aerobic exercise.

Evidence from repeated observational studies indicate a general inability in the UK to deliver this standard of therapy through existing models. There is then a clear argument for the more widespread adoption of technologies to support delivery of rehabilitation to stroke survivors. These technologies should be consistent with the principles of neuroplasticity, address the need to motivate and be widely accessible, including deployment in home and community environments.

Recent advances in brain-computer interfaces (BCI), robotics and brain and muscular electrical stimulation have the potential to significantly improve rehabilitation and will have the greatest chance of success when tailored to meet the needs of individual patients and used in combination. There are many interrelated challenges that must be addressed to ensure that these technologies can reach patients.

The KTN's Neurotechnology SIG convened a workshop on the 27th February 2020 which found that there are some high-level needs common to all types of stroke rehabilitation strategies:

- Greater accessibility
- Better technology
- Better evidence
- Education and training
- Patient acceptance

Greater accessibility is key to improving patient outcomes; stroke survivors need to receive the right treatment at the right time in the right place.

There is often a lack of awareness amongst therapists about what treatments exist (indeed, many stroke patients have a greater knowledge of the range of stroke rehabilitation technologies available). While this may in part be due to a heavy work schedule with little time to stay up to date with the latest technology advancements, there are certainly perceived dangers about new technologies making some therapists' jobs obsolete. More training should be available to therapists so they can stay up to date, but new technologies must be reframed as an opportunity for rehabilitation staff, which will enhance therapy and create new jobs. More training on the latest technological developments during undergraduate studies is also essential.

The right treatment, however, may not be available. There is an inconsistent uptake of rehabilitation services across the UK. Where treatments are available in a patient's area, it may still be difficult for the patient to reach due to inadequate transportation links that are not suitable to stroke survivors who often have poor mobility. If a patient is able to reach their therapy session, therapists have very limited time available per patient (approximately 30 minutes) as a result of NHS staff shortages. Moreover, current NHS therapy ends after just 6 weeks of treatment. For long term treatment, patients will either need to self-fund or join trials.

Some of these challenges are caused by the budget silos of the Health and Social Care systems. There needs to be more work done to identify the full costs of the NHS pathway to understand the impact of rehabilitation and where it may actually result in cost savings for the NHS in the long term. There must, therefore, be greater collaboration with health economists.

However, many of the solutions here require political interventions, for example, upgrading public transport links or greater funding for the NHS, so it is vital that these needs are clearly communicated to politicians.

Better access to in-home therapy would relieve some of the strain on the NHS and remove the burden of patients having to travel for treatment. Rapidly improving telemedicine could have a big impact, but the rehabilitation devices need to be designed at the outset with home use in mind. Some rehabilitation machines (e.g. walkers?) require people with PhD level training to run and maintain the machines. While this sort of equipment has been designed to produce the best possible outcomes, they have not necessarily been conceived with the ease of use of the patients and carers at the forefront of the design process. It is essential that developers use a human-centred design approach where the needs of the patients and carers are considered right at the start of the process. Patient groups are often eager to help with this type of development so situating innovation centres near hospitals will help.

Design must start with a need rather than a technology. For example, rather than asking how Virtual Reality (VR) could be better developed to meet a need, the first question must be; what are the best ways of meeting the need (which may in the end not even include VR). Therefore, it is essential to use multidisciplinary teams right from the start.

Simpler devices will be less daunting, potentially more affordable, easier to use and help with patient acceptance. Collaboration with the wearables sector could bring in design expertise. A further hurdle to overcome with many rehabilitation devices is boredom – it can take tens of hours of repetitive training before achieving meaningful results. This is particularly true of BCI, where the computer games used are rather rudimentary but up to 60 hours of training can sometimes be required to achieve lasting rehabilitation effects. Collaborating with the games industry could enable the design of far more engaging games. On the flip side, embedding BCI into conventional gaming hardware could provide an even more immersive experience for gamers and open up the technology to a much larger market, thereby reducing the costs of BCI hardware for the health sector.

There also need to be greater funding to bridge the gap between design and commercialisation of new rehabilitation technologies. This could be achieved by linking up the investor community through pitch events.

Patients are perhaps more willing to use new technologies than might be expected but they need to have the clinical evidence of effectiveness. Anecdotally, for example, when a stroke survivor was asked at the event whether she would have a brain implant, she immediately answered yes, if there is evidence to show that it will make a substantial improvement to her life.

More clinical trial will help provide this evidence. However, while there are many studies on different stroke rehabilitation technologies, it is often very difficult to compare the results due to different methodologies and a lack of standardised assessment measures. Not only is it difficult to compare across technologies, it is even difficult to compare studies using the same devices due to methodological differences, with some studies not being reproducible. There are also very few long-term studies (3-5 years).

While some studies may only find marginal gains when investigating the quantitative effects, qualitative effects can be more significant. The “feel good” effect must also be considered in rehabilitation studies.

An inherent challenge for stroke rehabilitation studies is the large spectrum of stroke patients but there need to be standardised experiments and better reporting mechanisms, which could perhaps be led by a new regulatory body. Stronger evidence will not only improve patient acceptance but also increase the likelihood of funding.



Figure 1. Needs and potential solutions for stroke rehabilitation.

With the evidence that is already available, there must be a robust analysis of neurological data which should result in a better understanding of the mode of action of different therapies. The artificial intelligence community could help undertake a new form of analysis on this sort of data. When commercialising new technologies, it is vital that claims match the evidence. Contacting NICE at an early stage will help companies focus their clinical trials in order to achieve NICE guidance and it is important to remember that NICE will also consider patient and carer testimony. Better evidence should improve patient acceptance but there must be more information available about different treatments. A TripAdvisor-type platform where stroke survivors can rate rehabilitation technologies could help assure patients that it is worth investing their time and effort in these therapies. Group therapy sessions would also allow stroke survivors to share their experience and help them feel less isolated. Finally, a greater awareness of ethics when developing new technologies will also help increase patient acceptance. There must be high level co-ordinated action to create ethics guidelines for business. Collaborating with the digital health community who already have ethical guidelines in place around the use of patient data could be beneficial.