Lending a hand

Professor Mary Galea discusses her work on the rehabilitation of upper limbs in stroke and spinal cord injury survivors and explains how it is being applied directly to a cutting-edge rehabilitation unit in Australia.

You are internationally renowned for your investigations into spinal cord injuries. How does your interest in such injuries link to your activities to help stroke survivors with rehabilitation?

While in clinical practice as a neurological physiotherapist, I treated many patients with stroke and other neurological conditions. I was fascinated by the motor function recovery process and how this could be facilitated. I went on to investigate the control of voluntary movement and its recovery after injury during my PhD, which focused on the development and organisation of the corticospinal tract.

The tract is the only direct link between the brain and spinal cord, and it is critical for control of voluntary movement. Injury to the corticospinal tract results in motor impairment. Stroke affects the cells at the origin of the tract in the brain. Spinal cord injury, on the other hand, affects the corticospinal axons as they descend in the spinal cord.

Between 30 and 60 per cent of stroke survivors do not regain functional use of their limbs. Why is this?

Recovery of function following stroke is contingent on a number of factors, including resolution of the pathophysiological effects of the stroke, the integrity of remaining tissue and post-injury experience.

While appropriate rehabilitation that involves the use of the paralysed limbs has been shown to induce reorganisation of the undamaged cortical areas and lead to functional recovery, sadly, little time is devoted to rehabilitation of the upper limb during inpatient rehabilitation. Moreover, since it has long been assumed that stroke survivors plateau in their recovery within three to six months, the combination of low expectations and the lack of resources directed to rehabilitation after discharge creates a self-fulfilling prophecy in which recovery of function is not realised.

You are deeply engaged in activities at the Royal Melbourne Hospital’s Hand Hub – an intensive hand and arm therapy centre. Can you discuss the results of an independent evaluation of the Hub's activities?

We evaluated the feasibility and effectiveness of the Hand Hub using a pragmatic clinical observational study. For a significant proportion of patients, the Hand Hub was their only experience of rehabilitation for the upper limb. Following the intervention, participants showed significant improvement in arm function and strength, and therefore quality of life.

Through this study, we have shown that the Hand Hub programme is feasible in a busy tertiary rehabilitation centre and that it is possible to build capacity in the provision of subacute rehabilitation services.

How would you like to see this study evolve going forwards?

The clinical benefits need to be further confirmed in a larger study sample with a longer follow-up. A cost-effectiveness analysis would provide additional evidence for implementation of this novel, inexpensive and motivating form of rehabilitation for the upper limb.

Can you discuss the Hand Hub’s future plans?

I am happy that the concept of the Hand Hub is now being adopted by other rehabilitation units so that inpatients may benefit from access to more upper limb rehabilitation. Plans are also well underway to establish a community Hub run by local stroke support groups.

Since it is often difficult for stroke survivors to travel to attend therapy, another major development will be to offer a tele-rehabilitation programme where stroke survivors may use one of the devices at home and have their performance monitored remotely by therapists at the hospital. It will be important to evaluate the effectiveness and cost-effectiveness of this programme if it is to be translated into routine clinical practice.
Handling upper limb paralysis

Researchers and clinicians at the University of Melbourne and the Royal Melbourne Hospital are working on establishing units dedicated to restoring upper limb function in people who have suffered strokes or spinal injuries.

The Pathway that controls voluntary movement is the only direct link between the brain and spinal cord. If key neurons are compromised in either area, paralysis can arise. A pertinent example is the paralysis evident in stroke survivors.

Strokes are one of the biggest killers in Australia annually – the National Stroke Foundation has found that one in six individuals will have a stroke at some point in their lifetime, and that approximately 440,000 people are living with the effects of stroke right now. This deadly disease generally occurs when the blood supply to the brain is impaired. A common blood vessel affected in stroke is the middle cerebral artery. When blockage occurs here, paralysis of the arm and hand is very likely.

Defeating Giants

It is no secret that the use of the hands and arms is essential to everyday activities; these body parts play a huge role in everyday life, enabling people to perform tasks like typing on a keyboard as well as activities of daily living such as getting dressed, preparing food and using a knife and fork. Unfortunately, these are tasks that many patients massively struggle with following a stroke. In fact, upwards of 60 per cent of stroke survivors never regain upper limb functionality.

There are many reasons why this is the case. The first is mindset. Traditionally, clinicians have had low expectations for recovery of arm function in stroke survivors. Because of this, treatments focus on helping stroke survivors regain basic functions, such as walking and balance, and often neglect the treatment of the upper limbs.

A second issue is a general lack of resources dedicated to rehabilitation. Technology provides a solution by enabling stroke survivors to exercise their affected arm and hand. The design of devices to help patients regain upper limb functionality is complicated and the devices need to be suited to varying levels of severity of arm and hand impairment – a very tall order, indeed.

Working to break through these challenges is Professor Mary Galea of the University of Melbourne and the Royal Melbourne Hospital. She established the Hospital’s Hand Hub, a pioneering unit aimed at the rehabilitation of the upper limbs through the use of both effective and affordable technologies. “The effect of loss of hand function on day-to-day activities is severe, as the hand provides the major interface between the brain and the world round us,” she states. “We at the Hand Hub are working to give stroke survivors back the functional use of their hands.”

In the Palm of the Hand

The Hand Hub is centred primarily on the immediate treatment of upper limb motor function, but also has an important secondary aim of monitoring the progress of its patients. Central to these two objectives are three devices that are designed for the recovery and improvement of motor functions in the hands and arms: Able-M, Able-X and the Re-Joyce.

All three are linked to computers on which the patient plays games using the device, and each is suited to different types of tasks. Able-M starts the patient on relatively simple arm movements. As such, it is a table-top exerciser for patients with severe impairment who have a small range of arm movement. Able-X is aimed
TECHNOLOGICAL SOLUTIONS FOR REHABILITATION

OBJECTIVE
To maximise rehabilitation benefits for patients following neurological conditions such as stroke by using advances in robotics, sensor and game technology to increase the practice of upper limb activities.

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MARY GALEA is Professorial Fellow in the Department of Medicine, Royal Melbourne Hospital, University of Melbourne. Her research programme integrates both laboratory-based and clinical projects with the overall theme of control of voluntary movement by the brain and factors that promote recovery following nervous system damage.

To overcome these issues, Galea and her team are working on a solution that overcomes the deficiencies of self-reporting, clinical and laboratory-based measures, by delivering a flexible, low-cost sensor that can be used to monitor a patient’s performance in their home environment. They are doing this by creating a wearable arm motion measurement device and by developing algorithms for classifying and measuring range of motion. Galea further explains the project: “We have a prototype sensor incorporating a triaxial accelerometer, magnetometer and gyroscope. The fusion of data from the three sensors has been shown to reduce noise and capture real motion with greater accuracy”.

A HAND IN THE FUTURE
Initial studies have shown that the Hand Hub has been effective and viable as part of the rehabilitation services in a hospital environment. In general, the participants showed a significant increase in their upper limb function, which has directly improved their quality of life.

However, the evaluation of the Hand Hub is still ongoing, and more work will continue to be done to study its effectiveness as a rehabilitation option. As part of this study, Galea and her team will work to further develop their home monitoring device. This device will enable Galea to continue checking the patient’s progress outside of the Hand Hub and confirm that the work at the unit is making a real difference, but as she states: “More work needs to be done. For example, we need to address the drift problem – the noise that arises when integrating the acceleration signal to obtain velocity or position information”.

In parallel to these activities, Galea hopes to show that the Hand Hub programme is cost-effective and could be adopted by most rehabilitation centres. Such an outcome seems likely to be positive given that the devices utilised by Galea are relatively inexpensive to purchase, they only require a standard computer and they reduce clinician contact time.

It is very promising for the future of stroke and spinal cord injury recovery that pioneers such as Galea are proving there is an effective and efficient route to the wider provision of upper limb rehabilitation. The continuation of her work should allow more rehabilitation centres to adopt Hand Hub-style units to improve access to rehabilitation of the upper limb for stroke survivors and may even offer new perspectives on the recovery from upper limb paralysis.