How did you come to work within the area of spinal cord injury (SCI) and the recovery of nervous system damage?

During my PhD studies I used a primate model of SCI – spinal hemisection – to investigate the anatomical substrate for recovery of hand function after injury to the corticospinal tract. This tract is the only direct link between the brain and spinal cord, and is critical for voluntary control of movement. I had previously undertaken a comprehensive investigation of the development and organisation of the corticospinal pathways, which showed that these pathways project in parallel from many different areas of the brain (not only the primary motor cortex) to every level of the spinal cord and have distinctive patterns of termination in the spinal cord. After spinal hemisection, the recovery of function was mediated by projections from the ipsilateral hemisphere, which crossed the midline at the level of the spinal cord.

What are the overall health implications for patients with SCI?

SCI can be considered an extreme example of deconditioning (the decline of physical capabilities) or movement deprivation. The immediate and severe loss of sensory and motor function leads to a period of ‘metabolic chaos,’ with systemic catabolism being triggered by the loss of normal physiological stresses to tissue as well as neurohumoral responses. Loss of normal muscle forces acting on bone also contributes to bone demineralisation. People with SCI may have cardiovascular and respiratory dysfunction, as well as immunosuppression, so they are more vulnerable to infections. Fractures and pressure ulcers, as well as systemic infections, are common. The metabolic profile of people with SCI is similar to premature ageing.

Can you discuss the main barriers encountered by individuals undertaking physical activity programmes within community fitness centres?

The main barriers identified were cost, lack of accessible facilities and assistance, physical and psychological issues, as well as weather conditions. Our Spinal Cord Injury and Physical Activity in the Community (SCIPA Com) programme involved the development of the Train the Trainers Spinal Cord Injury education programme, provision of training for exercise professionals and implementation of physical activity programmes in community fitness centres based on the physical strengths, personality and goals of participants with SCI. The implementation of the programme resulted in significant improvements in leisure time physical activity, quality of life and self-esteem of the participants.

With whom is the SCIPA programme collaborating in order to achieve its goals?

The support and cooperation of all the spinal units in Australia and New Zealand has been critical for the success of the SCIPA programme, and it forms the foundation for future research collaborations. Staff in all the units have been trained in clinical trials methodology and novel therapy interventions. The sites retain the equipment provided for the studies to benefit future patients. Above all, the SCIPA programme has raised the profile of exercise in the SCI community and has highlighted the importance of rehabilitation in maintaining optimum health and fitness and maintenance of the target systems below the level of injury.

Earlier this year you were recognised for your scientific achievements by being added to the Victorian Honour Roll of Women to mark this year’s International Women’s Day. How significant was this accomplishment to you?

It was a great honour to receive this accolade because the Honour Roll has recognised the achievements of many inspirational women from all walks of life. Having my scientific achievements recognised was especially important as this raises the profile of science in the community.
THE SPINAL CORD refers to the thin bundle of nervous tissue and support cells that extends from the base of the brain to between the first and second lumbar vertebrae. It is a key part of the central nervous system, connecting nearly all parts of the body to the brain. The spinal cord has three main functions: allowing the brain to send motor information to specific parts of the body; acting as a conduit for sensory information, which travels from the body to the brain; and finally, as the centre for coordinating quite sophisticated movement patterns, not only what we used to think of as simple reflexes.

Given the complexity of the spinal cord and its inherent role in multiple processes, spinal cord injury (SCI) can be highly detrimental, resulting in temporary or permanent changes to motor and sensory functions. In turn, these changes may negatively impact upon other parts of the body, causing problems as diverse as musculoskeletal deterioration, cardiovascular and respiratory difficulties and reduced efficiency of the immune system. Those with SCIs that are affected permanently or over a long period of time may also develop associated psychosocial issues.

CHANGING THE APPROACH TO TREATMENT

Professor Mary Galea, Principal Investigator at the University of Melbourne’s Spinal Cord Injury and Physical Activity (SCIPA) research programme, is leading multicentre randomised controlled clinical trials to better understand the effects of exercise on recovery, health and wellbeing after SCI.

Until recently, the clinical approach to SCI rehabilitation has used an initial assessment to determine the nature and extent of the injury, the results of which have been used to outline a course of treatment based on likely functional outcome. Types of treatment have typically focused on compensatory strategies that help patients to achieve the maximum level of independence possible. For those with clinically ‘complete’ injuries – those considered to have a permanent effect upon motor and sensory control below the lesion – this includes the provision of assistive devices and teaching new ways to carry out activities autonomously, as well as attempting to prevent further complications and re-integrate individuals into the community.

Latterly, new evidence from basic and applied science for activity-dependent plasticity of the nervous system has called this approach into question. Evidence shows that inactivity of people with SCI actually worsens the neurological impairments that are caused by paralysis. However, these deleterious changes can be partially reversed with appropriate therapy, as Galea elaborates: “It has been shown in numerous animal and human studies that locomotor training reactivates spinal cord central pattern generators. Furthermore, those with clinically complete injuries may retain some neurophysiological continuity across the injury site (discomplete injuries), and may therefore have potential for neurological recovery”.

Spinal cord injury and physical activity

The Spinal Cord Injury and Physical Activity programme at the University of Melbourne is collaborating with clinics throughout Australia and New Zealand, enacting a new approach to clinical rehabilitation which encourages the potential for recovery from serious injuries.
SCIPA

SCIPA is a five-year programme of research focusing on the effects of exercise after SCI and consists of four components, all of which focus on promoting neurological recovery, maintaining health and quality of life and optimizing function and independence. Three projects are multicentre randomised controlled clinical trials, which assess the effectiveness of early intervention for the lower limbs, task-specific training for the arm and hand, and the impact of activity-based therapies on the whole body, including paralysed limbs. The fourth component, the Spinal Cord Injury and Physical Activity in the Community (SCIPA Com) programme, concerns the implementation of a training programme for fitness instructors to work with patients with SCI. “Each of the projects deals with an issue of importance to the SCI community,” explains Galea.

The SCIPA programme uses a combination of laboratory research and clinical studies to provide an informed and controlled approach to new SCI treatment methods. Research measures the effectiveness of the trials, using both neurophysiological and functional assessments of neurological, musculoskeletal and cardiovascular systems. Social effects such as improvements to quality of life and community integration, as well as the economic viability of the new methods, are also taken into account.

IMPORTANCE OF EXERCISE

In 2011 a review entitled SCIs and physical activity: preservation of the body demonstrated that physical activity appears to be a potent factor in the maintenance of the health of the person living with an SCI, as well as maintaining optimal organ system function. The review outlined the important role of physical interventions in the recovery of SCI, concluding that physical rehabilitation of people with SCI must move away from the focus on coping strategies and encourage maintenance of optimum health and fitness. This includes targeting system function below the level of injury and the provision of suitable training, facilities and equipment. The report found the exercise of below lesion limbs to positively affect those with SCI in a number of ways, including the prevention and reversal of muscular atrophy, improvement of nervous system plasticity and prevention of cardiovascular disease and type 2 diabetes.

FUTURE PROJECTS

Continuing her interest in recovery of function, especially upper limb function after nervous system injury, Galea is now coordinating projects involving the electrophysiological evaluation of SCI and a study of nerve transfer surgery to improve upper limb function of people with tetraplegia. In addition, she is working on a project with stroke survivors, for whom it is crucial to regain the use of the affected upper limb. This project uses advancements in robotics, sensor and game technology to help patients increase practice with arm and hand activities.

Current evidence on the effectiveness of exercise in the rehabilitation of SCI is limited to a small number of controlled trials. The SCIPA programme will continue developing trials to provide a greater depth of scientific information on this subject. In the future, the scientists aim to continue their work by conducting specialised ventures into the optimal type and quantity of exercise for particular SCI sub-groups, ultimately improving quality of life outcomes for people with SCI.

CONTROLLED TRIALS

In 2009, SCIPA researchers started work on a multicentre randomised clinical trial called ‘Hands On’, which compared the outcome of typical care with an eight week intensive hand training programme. The programme used electrical stimulation to enable patients to grasp and release objects using a Bluetooth device, allowing them to participate in computer-based games and activities: “Participants drive the functional electrical stimulation of their hand via a behind-the-ear Bluetooth device, which is sensitive to tooth clicks,” details Galea. The trial collected data from 70 participants who are able to rate their perception of an increase in hand movement using an objective test of hand function. Follow-up assessments to this trial have now been completed, with results being released in the near future.

Another multicentre randomised trial commenced in 2011 – the ‘Full-On’ clinical trial study – and compared the neurological effects of a 12 week upper body exercise programme to a 12 week intensive activity-based therapy programme that covers the entire body. The activity-based therapies included locomotor training, trunk exercises and electrical stimulation-assisted cycling. “Although the final results are not yet available, the study has highlighted the difficulties of access to further rehabilitation of a large proportion of people with SCI, as well as the general vulnerability of this population,” Galea highlights.