THE LATEST IN SCI RESEARCH

Read on to find out what is going on in the world of SCI research at Aspire CREATe in Stanmore.

SEAN DOHERTY
SIA MEMBER

Back in 2008, I had a mountain biking accident and garnered myself a C5 SCI to go with my GCSE results. I'm now a biomedical engineering researcher at University College London and the London Spinal Cord Injury Centre in Stanmore. I thought I'd tell you a little about my journey and the research going on Stanmore currently.

I had always fancied being an inventor when I was young and have a passion for sports, so following my injury I decided to study engineering, thinking I would like to do sports engineering as a job. An SCI really gives you an appreciation for what technology can (or can't!) do to help people, so when I found out I could study medical engineering, I switched course and haven't looked back. Since then, I've completed a masters at Cardiff University, where I had a taste of engineering research and development by building geared wheelchair wheels (now in the shed, like all great projects ...). I enjoyed my four years in the Welsh capital and falling out of my chair too many times on 'a Cardiff night out'. While looking for jobs, I was fortunate to find an exciting PhD project working on new methods and devices for preventing bladder overactivity, or spasms, following SCI. So, in 2015 I started on this project in my current workplace at Aspire CREATe in Stanmore.

In 2014, Aspire, University College London and the Royal National Orthopaedic Hospital set up the Aspire Centre for Rehabilitation Engineering and Assistive Technology (Aspire CREATe) as a centre to conduct translational research, by which I mean getting novel ideas into practice to benefit people with SCI. Stanmore has a great history of SCI research, a tradition we aim to expand upon.

In my last four years at Aspire CREATe, I've seen a big growth in the research going on here and lots of new researchers have joined. I thought I would share a little detail on the research currently happening here, highlighting some exciting projects and outlining a few ways you can get involved as someone with an SCI (or a relation!).

PROJECT FOCUS

Getting control over bladder spasms – NEUROMOD

As many of us with SCI know all too well, the effects of an SCI on the bladder and bowel are not very kind. Very often, an overactivity of muscle of the bladder and sphincters develops that can lead to small bladder capacity (annoying) and overactivity or spasm that causes the bladder to contract involuntarily. This often leads to incontinence and Autonomic Dysreflexia (as well as danger for the kidneys!). It is currently treated by either using medications such as Oxybutinin or Mirabegron, by injecting Botox straight into the bladder, or by more invasive surgical options such as stitching some of the bowel onto the bladder to enlarge it. The treatments are not always effective or without risks, and surgery is not undertaken lightly.

NEUROMOD is the project I have been working on since 2015 with Dr Sarah Knight and Dr Anne Vanhoestenberghe. It aims to use electrical stimulation in the form of a wearable device to block the overactivity in the nerves controlling the bladder, a phenomenon called neuromodulation. The end aim of our work is to have a family of devices available that could both sense what is going on in the bladder and stimulate the right nerves to stop the bladder spasming to help maintain continence until a convenient time.

We started the project by comparing several different nerves related to the bladder that are possible to stimulate using stickers placed on the skin. For example, the tibial nerve, which counterintuitively involves stimulating down by the ankle – an ancient Chinese acupuncture point with evidence in many other patient populations – and the genital nerve, which involves sticker electrodes placed on the base of the penis or close to the clitoris. We compared the range of techniques by measuring bladder volumes and pressures as we filled the bladder through catheters and by measuring electrical activity in the anal sphincter – a huge thank you to the participants who volunteered both with and without SCI for these experiments! Science heroes.

We found genital nerve stimulation works very well, on average increasing the bladder capacity by 150ml or by over 100%, where the other (perhaps less intimate) sites weren't very effective. While there are concerns about discomfort, people who still had some sensation reported it as a buzzing sensation.

Since this first study, we have gone on to look at neuromodulation over longer periods and with people using a portable device in their home. So far, we have had people use the device for at least a day in the hospital followed by a week at home. The early results are promising, also indicating that we may be able to use a stimulation device in addition to medication.

We are now beginning a new set of trials, with Dr Lynsey Duffell joining the team, and we'll be asking SCI people with some residual bladder sensation to use a pocket-sized stimulation unit, discreetly controlled by a smartphone app, to deliver stimulation over a couple of months at home. We hope to find out whether bladder capacity is increased and incontinence decreased, both day-to-day and whether a longer-term beneficial effect is seen.

This project is funded by The INSPIRE Foundation in Salisbury. If you're interested in this type of research and wish to get in touch, feel free to send me an email via the details at the end of this article.

Non-invasive spinal stimulation for standing– Stim2Stand

In 2017, we were fortunate to have Dr Yazi Al'Joboori join us following a PhD exploring epidural stimulation and Chondroitinase ABC in rats, to work on an exciting new project led by Dr Lynsey Duffell on spinal stimulation.

While injury to the spinal cord can be severe and lead to complete loss of function below injury, some connections in the spinal cord may remain intact; but for unknown reasons, the spared circuits are inactive.

Electrical stimulation of the spinal nerves has been shown to encourage spinal circuits to produce leg movements while lying down. In recent years, many of you will have seen exciting results published using implanted epidural stimulation where there have been reports of improved standing function (when combined with intense rehabilitative training), as well as bladder, bowel and sexual function.

In this project, Yazi and Lynsey are assessing the functional benefit of using spinal stimulation in conjunction with sit-to-stand training over eight weeks. They have been using a non-invasive (above-the-skin) delivery of electrical currents on the lower spinal cord combined with rehabilitative sit-to-stand training provided by experienced trainers from Neurokinex.

Currently, five participants have completed the trial and a further five are beginning as I write. In the trial, people have been using stimulation during intensive rehabilitation exercises three times a week, with electrical activity in paralysed muscles being assessed throughout the eight weeks. Results from this study will be published when the training is complete and will provide valuable information on the effects of spinal stimulation on functional recovery.

This is another project funded by the fantastic INSPIRE Foundation.

Virtual reality and robotic therapy for neuropathic pain

Neuropathic pain can be a debilitating condition following SCI. Current treatments are not always effective and many drugs have significant side effects. In a new project, Dr Rui Loureiro and Peter Snow are looking to translate their early research successes in phantom limb pain and peripheral nerve injury into a new treatment for neuropathic pain following SCI.

Rui and Peter's work has involved engineering a system based on virtual reality and haptic robotics (robots that provide force feedback). This has led to a first-in-person clinical trial at the Royal National Orthopaedic Hospital and West Midlands Rehabilitation Centre focusing on the upper limbs.

Amputee participants with phantom limb pain were able to perform tasks using an immersive haptic training system. The device translates what the user can see in virtual reality (e.g. a replacement arm) into real world feedback (so it feels like they are using the arm as if it's their own). During the trial, participants interacted with virtual objects using their virtual arm. Participants have showed benefits (a reduction in pain) in this trial.

This work is now funded to expand the treatment in a two-year project to include people with SCI and neuropathic pain.

A toolbox of new techniques for tackling spasticity

Let's talk about spasms. Shaking, twisting, diving out of wheelchairs and generally doing the hokey cokey can really liven up a social situation. Particularly if there's a pint of beer in the mix. Whilst always good to have a laugh, issues with spasms are common and can contribute to severe muscle tightness, or spasticity, and seriously affect quality of life. This leads to the final project I'll describe here, looking into managing spasm and ensuing spasticity in the upper limbs in several ways. This project is led by Dr Rui Loureiro in partnership with the Stanmore SCI Centre.

The first part here in Stanmore focuses on the possibility of detecting consistent brain patterns associated with the onset of a spasm. The aim of the project is to see if we could develop a new method of SCI rehabilitation by combining the brain patterns with data about electrical muscular activity.

The second part is looking at using electrical stimulation to identify the nerve pathways that regulate spasticity. We are currently looking at different methods of electrical stimulation of those nerve pathways in people without SCI, so we can try to understand how we could use neuromodulation to help with spasticity in people with SCI.

Following this, we will be running a clinical study in 2020 with people with SCI who experience upper limb spasticity. The results of this study will contribute towards the pool of non-invasive methods available for the self-management of spasticity.

Finally, we are researching the application of vibrations during robotic-assisted therapy to relieve symptoms of spasticity and enhance residual voluntary movements in the wrist. Vibration stimulation seems to be an affordable and easy-to-use rehabilitation tool. Focal muscle vibration has potential to reduce spasticity and enhance muscle strength and performance. Our study is looking at combining vibration with robotic assisted movement therapy in a trial called VIBROfocus. Following focal vibration to relax spastic wrist muscle, the wrist is engaged in a robot-assisted game playing "Pong" against a computer.

Results from two participants who have completed the trial so far showed short-term decrease in wrist stiffness, but also improved active and passive range of motion. The findings are being used to recommend a clinical therapy for spasticity.

This project is funded by The Leslie Trust and is always after user input and participants with and without SCI.

And all the rest ...

There are plenty of other projects that we're currently researching: smart wheelchairs, soft robotic hand exoskeletons for tetraplegics and improved FES cycling, to name a few. Please have a look on our website where we have more details, including a growing list of scientific publications for anyone wishing to dig deeper. Visit www.ucl.ac.uk and use the search tool to look for 'Aspire CREATe Centre for Rehabilitation Engineering and Assistive Technology'.

Get involved!

At Stanmore, we're trying to increase the involvement of SCI people in our research, as you're the experts on living with SCI!

Involving people with lived experience of SCI is very important for researchers to be able to make sure they're working on the right problems in the right way. It's also important for the SCI community to make sure research is planned and conducted with user input, on the issues that matter most.

If you're interested in a particular project, would like to advise on future projects or feel there are specific areas that need investigating, then please get in touch with me or other researchers listed on our website.

To register interest in being involved in the ongoing planning of research, send a blank email to **aspire-create-ppi@ucl.ac.uk**

Of course, we are also always seeking participants in trials of new therapies or hypotheses! To hear about our future trials, send a blank email to **aspire-create-research-join@ucl.ac.uk**