



or exoskeletons trotting or walking or jerking their legs. News sites report on these findings frequently with headlines like, “Paralyzed rats walk again”.

Great. But.

“None of them can balance,” Cowley says. “It’s a testament to the inherent capacity of the spinal cord to be able to generate steps—but it’s a bit of a parlour trick when headlines indicate that voluntary locomotion has been restored in these experimental animals. Even a completely spinalized—scientifically paralyzed—“animal can produce stepping if you give them training or drugs or electrical stimulation. But none of them will be able to balance and remain upright.”

You may come across Internet videos showing people or animals with spinal cord injuries standing upright. But the tools enabling this—epidural stimulators—are crude. It can take up to a year to try to find the correct stimulation to get any response. They can simultaneously activate flexor and extensor muscles, giving the subjects a rigid posture. The researchers don’t know what they are activating or where to stimulate to get desired, useful results.

When your brain sends a command for you to stand up, we don’t know what pathways it takes—for example, dorsal or ventral. And once you’re standing, scientists don’t know which areas remain activated in the spinal cord.

“Is there a spinal stance generator? We don’t know. There is evidence from animal literature from 40 or 50 years ago suggesting it may exist. But we can use these *in vitro* preparations to understand the neural circuitry that

is involved in maintaining an upright posture and responding to balance perturbations.”

Understanding this will take some time. And when we do understand it, will it be enough to help someone like Cowley walk again? Maybe not. But once we know the fundamentals, once we understand balance, we can use this knowledge to design therapeutically useful interventions. These interventions may not completely restore function, but they could be used to slow the musculoskeletal decline that is currently inevitable after spinal cord injury.

Every wheelchair-bound person will develop osteoporosis in their legs at some point, and within five to eight years after injury the inevitable fractures begin; reports suggest 50 per cent or more will suffer at least one low-impact or spontaneous fracture in the decades after injury.

“This has huge social and medical costs,” Cowley says.

What is more, if people with spinal cord injuries are to ever walk again, their bones must be up to the task.

If you can get people to stand with appropriate stimulation of the spinal cord, maybe you can turn the stimulator on, stand up, reach a few things, and sit down. Or maybe you can turn it on and stand up long enough to put stress on the bones and delay or prevent the bone density loss that leads to osteoporosis.

After Cowley earned her PhD, she began collaborating with others at the U of M like Brian MacNeil in the School of Rehabilitation Medicine. They worked to develop an adult rat model of spinal cord injury to test whether their findings *in vitro* regarding the neural basis of stepping and stance and balance could be translated to the adult. This also enabled Cowley to begin investigating ways to reduce secondary complications related to spinal cord injury. Cowley developed an adult rat model with which to test activity-based therapies: for their potential to reduce osteoporosis and musculoskeletal decline after spinal cord injury. Cowley will soon begin investigating how spinalized rats respond to standing on their hind legs, while supported, on a vibrating plate. Will this preserve bone density? She will be the first to investigate this—other researchers have examined sheep and the results were remarkably positive, but the animals were not spinalized.

By combining the resources within the Spinal Cord Research Centre and the small animal imaging facility at the U of M, teams like Cowley’s can investigate these

potential treatments in a controlled, systematic research model that will take mere weeks in an animal model rather than the years needed to determine if the therapies work in humans with spinal cord injury.

She also collaborates with Dr. Karen Ethans, the medical director of the spinal cord injury programs at the Health Sciences Centre, and Dr. Barbara Shay, head of physical therapy at the U of M. Together they are trying to find exercises that people with spinal cord injuries can do that will effectively lower rates of diabetes, cardiovascular disease and obesity in this population. This type of research has an almost immediate potential for clinical applications for the roughly 80,000 Canadians living with a spinal cord injury.

“In many ways,” Cowley says, “Winnipeg is the ideal place for both studying how the spinal cord functions, within the Spinal Cord Research Centre, and for more clinical research, working with people living with spinal cord injury. We have a centralized spinal cord injury rehabilitation facility with long-term follow up for the province, as well as connections to community based organizations like the provincial Canadian Paraplegic Association.”

Cowley herself is the former executive director of the Canadian Paraplegic Association, a role that has influenced her research career.

Why this research? The motivations are multiple.

Cowley’s motivation in researching the role of the nervous system in stepping and balance comes from her general interest in figuring out how things work. After sustaining a spinal cord injury at C8, just after finishing second year university, she realized there were many physical barriers to completing a medical degree, so she decided to focus on research instead. Since she has always been interested in how things work, physiology made sense.

As executive director of the Canadian Paraplegic Association, she observed the many hundreds of people living out the decades after injury dealing with these multiple and currently untreatable secondary consequences of spinal cord injury. That experience motivated her in her work to reduce muscle deterioration.

Her interest in the effect of exercise on spinal cord injury comes from years competing as a Paralympic wheelchair track athlete, and seeing the benefit of training on those living with spinal cord injury.

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“What’s interesting is if you survey people with spinal cord injuries, they don’t rank walking as their number one thing. Balance ranks higher than stepping in terms of ‘what are the things each person would like to recover.’ And if you think about it, it makes sense because balance affects everything we do.”

Would she prefer balance to stepping?

“Yes, I’d like to stand up. But that’s not motivating this. This is motivated from a number of years of looking at locomotor research and saying, ‘Well, what’s missing? What do we need to do?’”

She looks at her computer screen again, saying, almost to herself, “We can generate stepping, but how are we going to remain upright?” ■

