

## Upper-Extremity FES Systems Making a Comeback

by James Cavuoto, editor

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The market for upper-extremity functional electrical stimulation systems, which suffered with the demise of NeuroControl Corp.'s Freehand system nearly 10 years ago, is poised for resurgence. Several research institutions and commercial firms have devised new systems that help restore function to individuals with tetraplegia resulting from spinal cord injury.

Researchers at Case Western Reserve University and the Cleveland FES Center, who developed the original technology for the Freehand device, are continuing their work on a next-generation device, which has the capability of interacting with a modular, multifunctional system under development. Last fall, FES Center executive director Hunter Peckham was awarded a \$7.4 million grant from the NIH to develop the multifunctional neuroprosthetic system.

Last year, [Bioness Inc.](#), the Valencia, CA manufacturer of neural prostheses, submitted a 510(k) application for its StimRouter implanted peripheral nerve stimulation device, which consists of an implanted passive lead coupled with external electrical energy. The company acquired the device from University of Alberta researcher Arthur Prochazka.

Researchers at the University of Toronto and Toronto Rehab recently published a study that reported that FES "significantly" reduced disability and improved grasping in people with incomplete spinal cord injuries, beyond the effects of standard therapy. "This study proves that by stimulating peripheral nerves and muscles, you can actually 'retrain' the brain," said the study's lead author, Milos Popovic, a senior scientist at Toronto Rehab and head of the hospital's neural engineering and therapeutics Team. "A few years ago, we did not believe this was possible."

Reporting online in the journal *Neurorehabilitation and Neural Repair*, the team said that study participants who received stimulation also saw big improvements in their independence and ability to perform everyday activities such as dressing and eating. Unlike permanent FES systems, the one designed by Popovic and colleagues is for short-term treatment. The therapist uses the stimulator to make muscles move in a patient's limb. The idea is that after many repetitions, the nervous system can 'relearn' the motion and eventually activate the muscles on its own, without the device.

The randomized trial involved 24 rehabilitation inpatients who could not grasp objects or perform many activities of daily living. All received conventional occupational therapy five days per week for eight weeks. However, one group (9 people) also received an hour of FES therapy daily, while another group (12 people) had an additional hour of conventional occupational therapy only. (Three patients did not complete the trial.)

Comparisons between the functional abilities of the two groups showed that stimulation

therapy “significantly reduced disability and improved voluntary grasping beyond the effects of considerable conventional upper extremity therapy in individuals with tetraplegia.” Popovic noted that patients who received only occupational therapy saw a “gentle improvement” in their grasping ability, but the level of improvement achieved with FES therapy was at least three times greater using the Spinal Cord Independence Measure, which evaluates degree of disability in patients with spinal cord injury.

Based on their findings, the study’s authors recommend that stimulation therapy should be part of the therapeutic process for people with incomplete spinal cord injuries whose hand function is impaired. Popovic’s team is working to make this a reality. They have almost completed a prototype of their stimulator, but need financial support to take it forward. Popovic thinks the device could be available to hospitals within a year of being funded.

“FES has the potential to have a significant and positive impact on the lives of individuals living with the devastating results of spinal cord injury,” said Anthony Burns, medical director of Toronto Rehab’s spinal cord rehabilitation program. Calling the trial “groundbreaking,” Burns said he will work with Popovic “to make this intervention available to our patients, and to answer important questions such as the duration of the effect.”

One limitation of the study is that the research team could not get all participants to take part in a six-month follow-up assessment. However, six individuals who received FES therapy were assessed six months after the study. All had better hand function after six months than on the day they were discharged from the study. Another study, now underway, will determine whether stimulation therapy can improve grasping ability in people with chronic incomplete spinal cord injuries.

Although technically not FES devices, there are several upper-extremity stimulation systems currently on the market used for stroke rehabilitation that exploit principles of cortical plasticity. These include the [Zynex](#) NeuroMove NM900 and the [Otto Bock](#) Stiwell med4 system.