moves in the harness, the system stays above him or her. It is helpful for patients to have some movement in their legs, although ZeroG can be used to help with sitting balance and other posture control activities. By unloading a portion of the patient’s weight, the system makes it easier for the patient to begin practicing very early after the stroke, which is important for improving outcomes.

“If patients have significant impairments, therapists can start them with simple balance tasks, such as standing and improving their trunk control,” Dr. Hilder said. This is all done with a great deal of body-weight support. As the patients get stronger, the therapist can slowly advance the patient to walking and other therapeutic activities, decreasing the level of body-weight support. “The powerful feature of ZeroG is that it lets patients of all abilities safely practice gait and balance activities.”

Because they are not confined to a device like a treadmill, survivors can practice walking with obstacles such as stairs and uneven terrain and use other assistive devices, like canes. The clinical version of the ZeroG in use at NRH runs on a 65-foot candy-cane-shaped track with a treadmill positioned at one end. This allows ZeroG to be used for both overground and treadmill training.

Improving Upper-Extremity Movement

ReoGo

For many stroke survivors, it is easier to relearn walking than to regain use of an affected arm, and regaining the use of an affected hand is even more difficult. This is likely because reaching for and grasping something in three-dimensional space requires muscle and neuron sequencing that a stroke interrupts. Many therapists and engineers have been investigating how to retrain survivors’ arms, and there have been a number of robotic devices designed for this. The ReoGo by Motorika is the only one currently available outside a laboratory.

The ReoGo is a computerized robotics-based system that assists survivors in retraining their affected arms after stroke. Susan Ryerson, a physical therapist and research scientist at the National Rehabilitation Hospital in Washington, uses the ReoGo in her physical therapy practice Making Progress. She explained that what is often described as “muscle weakness” is actually an impairment of the ability to sequence a number of small movements that have to happen almost simultaneously in order for a person to reach in space.

“The ReoGo helps train sequence and movement patterns by progressively challenging survivors with more complex movements,” Ryerson said. “It allows the patient to progress from the simplest mode, where the machine is guiding the pattern and patients are essentially following, all the way to a pattern where they are actively initiating and leading the movement themselves against resistance.” In addition to these two settings, the device has three intermediate modes:

- **Initiated mode** where the survivor starts the movement and then receives assistance in completing it;
- **Step-Initiated mode** where the survivor starts several movements at different points in movement trajectory that the device then completes; and
- **Free mode** where the device is only taking the weight of the arm and the survivor controls the movement.

In each mode, patients are responding to a computer screen that provides a
real-time simulation of the movement being executed on the motion unit. Patients get immediate feedback about how effective their movement is. A variety of software requires different kinds of movement and keeps the activity challenging and meaningful. Programming also provides an automatic stop if patients are doing something that endangers them.

The ReoGo also allows patients to make many more repetitions of each movement. “With the robot a survivor can do 300–350 repetitions in an hour, instead of the 30-40 you might get with conventional therapy,” Ryerson said. “The high number of repetitions makes a big difference in functional recovery.” Research indicates that repetition affects brain plasticity.

Although a therapist is needed to set the device up, survivors can then do the exercises on their own. “The ReoGo is easy to use, and once patients are evaluated and set up, they can do the work themselves,” Ryerson said. Because it is computerized, the ReoGo allows exercises and sessions to be customized as well as recording of results and therapist notes.

Insurance companies consider the ReoGo experimental and do not specifically reimburse for its use. Currently the National Institutes of Health is doing a study on its effectiveness, so its billing status could change.

GOOD VIBRATIONS

Stimulating the brain with waves of energy seems logical, but up until this century it has occurred mostly in the realm of science fiction, like Frankenstein. But this concept has generated increasing interest in the past decade. Two forms of energy have been investigated: transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS). Although neither has been approved for use with stroke patients, they have shown promising results. We talked to two experts in this field. Dr. Felipe Fregni, M.D., Ph.D., M.P.H., is assistant professor of neurology at Harvard Medical School and director of the Laboratory of Neuromodulation at Spaulding Rehabilitation. Michelle Harris-Love, PT, Ph.D is a research scientist at the National Rehabilitation Hospital in Washington.

TMS

Transcranial magnetic stimulation uses a magnetic field to stimulate neurons to fire. These electrical currents are induced in the tissue by rapidly changing magnetic fields created by an electric current passing through plastic-covered coils held against the head. It is delivered by a device about the size of a suitcase. It is essentially painless, though patients may experience a slight headache.

“The sensations are often described as more annoying than uncomfortable,” Dr. Harris-Love said, “a feeling of being tapped repeatedly on the head with the eraser end of a pencil.”

tDCS

Transcranial direct current stimulation uses a constant electric field that induces a weak current that creates changes in the neuron’s membrane and regulates its electrical activity. In tDCS, the electric current does not cause the nerve to fire. The device used to deliver tDCS is small enough to be powered by a 9-v battery. Pain is not an issue with this method either.

The goal of both types of treatment is the same. “In general, the goal is to ‘up-regulate’ neuronal activity in areas we think are important for recovery,” Dr. Harris-Love said, “or to ‘down-regulate’ activity in areas that we think may have become ‘over-activated’ due to the stroke.”

“TMS and tDCS can promote and restore normal activity in areas where it has been disrupted. These devices can be thought of as a pacemaker for the brain with an addition of inducing long-term plastic changes,” Dr. Fregni said.

Both methods are used in conjunction with conventional rehab activities. tDCS is often used during the rehab activity to improve the activity’s effects on the brain. TMS is typically used before a rehab treatment session.

Both experts were clear that we are at the beginning of the process. “A number of ‘proof of concept’ studies have been performed,” Dr. Harris-Love said. “But larger, well-controlled, multi-center, double-blind trials carried out in a clinical setting are yet to be performed. Many questions remain in regard to dosage and timing of treatment, which patients are most likely to benefit, and unanticipated risks.”

They also expressed confidence that these treatment methods will eventually prove helpful to survivors. “This kind of treatment might enhance the effects of other therapies inducing learning and neuroplasticity,” Dr. Fregni said. “It is difficult to quantify with the data we have so far, but it’s promising.”

Dr. Michelle Harris-Love

Dr. Felipe Fregni