Brain Stimulation and Robotics-Assisted Motor Training: Moving Past Brain and Nerve Injury

In part II of this series, a researcher explains how technology is supporting recovery.

A Q&A WITH DYLAN EDWARDS, PHD, PT

Brain stimulation and robotics assisted motor training may help stroke patients and others with brain and spinal cord injuries. Last month, Dylan J. Edwards, PhD, Director, Non-Invasive Brain Stimulation and Human Motor Control Laboratory at Burke Medical Research Institute and an assistant professor of neurology and neuroscience at Weill Cornell Medical College described some research findings. (Read the story at PracticalNeurology.com) Ahead he offers more insights into future research and applications.

What are some of the questions to be investigated if the current study pans out? What are the next questions for this intervention?

Dr. Edwards: We know that this combination of treatment that we’re offering can be profoundly beneficial. Some people have a really stellar improvement. We know that it has a good side effect profile so there are virtually no side effects or any side effects that are present are minimal; they’re things like maybe some tingling or mild headache from the electrical device. But they are equally present in the sham condition where they are not actually getting stimulated. So, really, they have a fantastic side effect profile relative to other treatments available.

And we know that they don’t make people worse and generally only make people better from our data. We have a lot of literature to support this.

But some limitations at present are that we don’t understand why some people respond better than others, whether it’s some genetic predisposition, whether it’s the brain state at the time of the therapy, whether it’s how well they’re participating in the therapy. There could be multiple explanations, but certainly we’re seeing inter-individual variability. That’s a little bit of an impediment to progress because we’re reluctant to run a full scale clinical trial or even to say that it was going to benefit everyone because it doesn’t benefit everyone, but potentially it could.

I think both the techniques—transcranial brain stimulation and robot-assisted therapy—have a lot of potential, they’re already showing great strides in some people, but the interindividual variability is the remaining weakness that I can see and we’re trying to put a lot of effort into that.

Is there anything out there that might be associated in peoples’ minds with this that they need to understand is different?

Dr. Edwards: I don’t know any other group in the world that’s doing the protocol that we’re offering of brain stimulation combined with robotics.

I think that both of these terms, brain stimulation and robotics, have a huge wow factor and run the risk of being incompletely understood and it’s not only by laypeople, it’s by the professionals, as well, even people who are studying the area, because they encompass such a broad concept.

To say that brain stimulation works is not really a valid thing to say, because it depends on what type of brain stimulation and how it’s applied. By changing around the way we stimulate the brain is like fiddling with the
composition of a drug and expecting it to have the same effect. In fact, we published an article in *Nature*, a correspondence that addressed this exact thing for brain stimulation because it’s becoming so popular, secondary to some papers that came out, not in patients actually but in healthy subjects, showing that it would improve mapability and it can enhance performance.

Many people are trying to build their own devices and you can in fact see how to do this on YouTube. There is one approved device called a cranial electrical stimulator, CES, that was grandfathered in by the FDA, so it is actually approved for brain stimulation, and all of the others are experimental and IRB approved.

But clearly there are many different types of brain stimulation devices out there and to say that they’re all the same thing is absolutely inaccurate.

The gist of the article we published in *Nature* was to say that some of us are going to painstaking efforts to understand the best possible electrode configuration on the head, the type of electrodes, the kind of conducting gel or saline that we use, the sort of currents that are passed, the anatomical flow of current based on individual MRI scans, the physiological consequence, the potential for tissue damage, depending on current density. These things take an exquisite level of scientific rigor and investigation and without that people run a risk of potentially having adverse effects but certainly reducing the possibility of effective brain stimulation.

But really I would advise consumers to, for brain stimulation because it’s so new, and because it does have the potential to have adverse effects, although done safely it has a very good risk profile, that they should really be directing their questions to reputable centers.

There are several around the country. They’re usually associated with universities such as Cornell here, or Harvard University in Boston, or UCLA in Los Angeles. So, there are several centers around the country, people could direct their questions to, but they shouldn’t be building their own and they shouldn’t be watching videos on YouTube about how to actually apply it.

The Institute of Medicine is interested in looking at this a bit more closely and seeing whether, how much of a viable and reasonable option it is, brain stimulation, perhaps a treatment alternative to medication. So, that’s currently underway and a lot of work’s going into that.

For the robotics, again, robotics can be interpreted however you please. Essentially there are many different types of robotic devices, and I try and educate people as I go around and give lectures on this topic about what a robotic device is because an electromechanical device isn’t necessarily robotic because there’s many devices like that in your gymnasium that you go to.

A robotic device really is often patient centered, it has safety features built in so that it can’t produce too much force, it has very exquisite control and it has all of the features I mentioned at the start of this interview about feedback and progression, and interaction with the patient. So, unless a particular robotic device meets those criteria, it’s not really a robotic device.

Only several places around the country effectively use robotics for rehabilitation. Some of the larger rehabilitation centers and some of the teaching hospitals, as well as the major universities. They’re becoming progressively adopted and you can expect to see more of these around; the price is coming down, and people are starting to learn about them.

**Is there anything that clinicians can be aware of and maybe start to, even at this point, direct their patients to that could be helpful for them?**

**Dr. Edwards:** I think if the clinician felt that the patient...
could benefit from physical therapy, which would include the subacute stroke period where they do this routinely, as well as the chronic stroke period, greater than six months or a year, and even a long time after stroke, twenty, thirty years potentially, then they should be a candidate for robotic exercise. And they should be encouraged to try and seek it out because of the dose that can be delivered.

It’s well published that a regular therapy session typically has well under 100 repetitions across a whole 45 minutes to an hour session, because the therapist has so many other things to focus on, and the robotics deliver around 1,000 repetitions per session. And we know certainly from the animal literature and from the human work that you simply need that kind of number of repetitions if you want to have adaptation improvement in function.

Early on in stroke, people believe that there’s a certain amount of spontaneous recovery occurring independent of the interventions that we do as clinical researchers and clinicians. Therefore, if you are trying to prove that intervention ‘A’ works, it’s easier to do it when the person is stable and they’re not recovering anymore, because you prove that they’re stable, you then apply the intervention or a sham intervention, and you show that the intervention works relative to sham.

Early on it’s more difficult because there’s a changing baseline, so it’s harder experimentally to deal with. All of that said, it means that most of the work has been done in the chronic stroke period to prove efficacy of both of these techniques actually.

Does that mean that the early period after stroke would not be beneficial? Quite to the contrary, actually, we would expect that the early period is very, very important. And people are heavily investigating this now. But it’s just that the overwhelming body of evidence is in the later stroke period.

Physicians, if they think that their patients could safely participate in an exercise regimen, then they should be encouraged to seek out these robotic therapies. If the place does supplementary brain stimulation, under controlled and ethics approved circumstances, then that would be an option also.

The patient needs to be able to be engaged in the therapy themselves, whether they’re having supplementary brain stimulation or not. So, they tend not to have such a good response if the patient can voluntarily contribute to the movement that they are trying to repetitively practice. So, there probably is an optimal window of functional level that’s suitable for patients, very, very severely effected patients who can’t, with no volitional movement, who are completely paralyzed probably aren’t going to benefit a lot from the robotic therapy. That is, in terms of regaining independent limb control, although they may get orthopedic benefit and painful shoulder relief.

Brain stimulation we’re still investigating and the combination we’re still investigating, but they need to be able to participate a little bit.

And then for people who are really quite good, maybe robotic therapy is a bit of overkill for them; they could possibly just be doing other therapies. It doesn’t require the expense needed for the multiple robotic sessions, because they can probably do home exercises just under the guidance of a therapist.

There’s probably a window from moderately severe to only a little bit of dysfunction that would be optimal for the robot, which is quite a broad spectrum of the stroke population actually. So it means a lot of people could potentially benefit. But I wouldn’t advise really severely affected people to participate in the hope that they’re going to regain full function; that would be inappropriate.

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