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How Robots Are Aiding Stroke Rehabilitation

A generation of devices helps patients with disabled limbs practice—and recover—a range of motions

By Nancy Shute
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Robots are invading stroke rehab, and that's good news as far as Bill Journey is concerned. He worked hard to recover from a stroke in the early 1990s but was never able to walk without a cane. Three years ago, his doctor asked him if he'd like to try an experimental robot called the KineAssist at the Rehabilitation Institute of Chicago, near his home. Journey, retired electrician who was an avid runner before his stroke, feared falling more than anything. But when he was buckled into the KineAssist's harness, which is supported by a box the size of a small closet, Journey found he no longer had to fear: "It'll catch you if you think you're going to fall." Walking while pulling the robot's box behind him wasn't easy; it would "beep" at him if he didn't use his weak leg, and at first Journey was exhausted after 15 minutes. But after a few months of twice-weekly sessions, he decided it was time to leave his cane at home. Journey is now 70, and he hasn't used a cane since.

For the past 20 years, robots have been billed as the next big thing in stroke therapy, a way for stroke patients to get more intensive therapy and recover more function. Models work differently, but in general they involve sensing the user's intention, and then following along as if connected with springs. The robots "know" to help a severely impaired patient move a limb if he cannot, or, as with the Lokomat, sense if they are falling and catch them. About 700,000 people suffer a stroke each year, and 90 percent have significant impairment afterwards. But until very recently, therapeutic robots have offered little more than promise.

Now, robots are finally making their way out of the lab and into rehab. This summer, the Rehabilitation Institute started using KineAssist with regular patients. Next week, the robot will be deployed to Alexian Rehabilitation Hospital in Elk Grove Village, Ill. The Lokomat, another robot for

Stroke victim Bill Journey demonstrates physical therapy techniques using the KineAssist.
(Scott Olson/Getty Images)

Video: Stroke, Explained

lower-limb therapy developed in Europe, is being used more commonly in the United States. And several upper-arm trainers are being tested in VA hospitals and other clinics to see if they're cost-effective for widespread use in rehab—or even therapy at home. "I think it is ready for general clinical practice," says Hermano Krebs, an MIT mechanical engineering professor who helped invent the MIT-Manus, a robotic arm that a patient straps on and moves to connect dots on a video screen. The robotic arm provides resistance calibrated to challenge the user just enough so that muscles get stronger. The improvements have been small, Krebs says—a 5 percent increase in shoulder and elbow movement. "But this 5 percent is enough to allow a person to go from taking a shower assisted by an aide to taking it themselves."

Journey's improvement jibes with growing evidence that the adult brain is "plastic," able to build new connections between neurons as workarounds for brain parts damaged by stroke. Repetitive practice seems to spur construction of those new connections, even long after the injury.

"Robots give you tremendous opportunities for repetition and practice," says Pamela Duncan, chairman of the American Stroke Association's Stroke Council, and a professor in the division of physical therapy at Duke University. "Even the best therapist can't give you that." The MIT-Manus, for instance, can help a patient move her arm 800 to 1,000 times in a 45-minute session, compared with 60 to 80 times with a physical therapist. Physical therapists are in short supply, too, and therapy can be hugely labor-intensive. For instance, it can take two or more therapists to help a patient practice walking between parallel bars: Ideally, there's one on the ground to pull a foot forward with each step, one standing to move the patient's hand on the parallel bar, and another steadying from behind. Practically, this means that stroke patients often get less than optimal amounts of physical therapy.

However, even fans of rehab robots say that stroke patients should exercise caution when considering robot therapy. "It would be premature to make a strong case for people to seek them out," says Zev Rymer, medical director at the Rehabilitation Institute of Chicago. One reason is that researchers are still in the process of figuring out which patients would get the most benefit out of robotic therapy, so it isn't easy for doctors or therapists to write a "robot prescription."

A human therapist, moreover, excels at helping a patient practice moving a limb in different directions, as it's used in real life, whereas the robots move in only a few planes. Robots are expensive: A KineAssist or a Lokomat costs upwards of $250,000, putting them out of the reach of most rehab facilities. Robots designed for arm therapy are less expensive, more like $60,000, and simple enough that it's possible to imagine them being used at home. The Armeo, which was developed at the University of California-Irvine and the Rehabilitation Institute of Chicago and is now sold commercially, uses the equivalent of big rubber bands to provide resistance. A video screen measures progress, and patients can compete against themselves. "There's nothing magical about it," says Rymer. "It's the frequency and intensity of practice."

And rehab experts say those two words—frequency and practice— give stroke patients the best clue as to what to do while waiting for the robots; frequent repetitive motion seems to be the key to building not just stronger limbs but new connections within the brain. It doesn't take a robot to do that. Patients should take advantage of every bit of therapy they're offered, the doctors say, work hard while they're there, and realize that gains can be made even years after a stroke.

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