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Robotic therapy helps stroke patients regain function

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A patient uses a robotic therapy device invented at MIT. The robotic joystick guides the patient's arm as he tries to move the robot handle toward a moving or stationary target shown on the computer monitor. If the person starts moving in the wrong direction or does not move, the robotic arm gently nudges his arm in the right direction. Photo: Department of Veterans Affairs

(PhysOrg.com) -- Stroke patients who received robot-assisted therapy were able to regain some ability to use their arms, even if the stroke had occurred years earlier, according to a study published April 16 in the online issue of The New England Journal of Medicine.

The study, which examined the effectiveness of a class of robotic devices developed at MIT, found that in chronic stroke survivors, robot-assisted therapy led to modest improvements in upper-body motor

function and quality of life six months after active therapy was completed; these improvements were significant when compared with a group of stroke patients who received the traditional treatment. Moreover, the robotic therapy — which involves a more intense regimen of activity than traditional stroke therapy — did not increase total health-care costs per stroke patient, and could make intensive therapy available to more people, say the researchers who led the study.

The study results also challenge the notion that physical therapy only benefits stroke patients within the first six months after the stroke, says Albert Lo, a neurologist at the Providence VA Medical Center who led the study.

“There are nearly six million stroke patients in the U.S. with chronic deficits,” says Lo. “We’ve shown that with the right therapy, they can see improvements in movement, everyday function and quality of life.”

Mind and body

The study, conducted at four Veterans Affairs (VA) hospitals, found that patients who used the MIT robotic devices for 12 weeks experienced a small but significant gain in arm function. Another group of patients who received high-intensity therapy from a therapist, which matched the number and intensity of the robot movements, showed similar improvements.

Hermano Igo Krebs, a principal research scientist in MIT’s Department of Mechanical Engineering who developed the MIT-Manus robot, has been working on robotic therapy since his graduate student years at MIT almost 20 years ago. In his early studies, he and his colleague, Professor Neville Hogan, found that it’s important for stroke patients to make a conscious effort during physical therapy.

The MIT-Manus system, which Krebs started developing more than 20 years ago, is based on that principle. The patient grasps a robotic joystick that guides the patient's arm, wrist or hand as he or she tries to make specific movements, helping the brain form new connections that will eventually help the patient relearn to move the limb on his or her own.

In the New England Journal of Medicine study, researchers at VA hospitals in Baltimore, Seattle, West Haven, Conn., and Gainesville, Fla., compared the MIT-Manus system to a high-intensity rehab program delivered by a human therapist, which was designed specifically for this study.

Each group included about 50 patients, who were also compared with a group of 28 stroke patients who received so-called "usual care" — general health care and three hours per week of traditional physical therapy for their stroke-damaged limb.

Patients using the MIT-Manus system grasp a joystick-like handle connected to a computer monitor that displays tasks similar to those in simple video games. In a typical task, the subject attempts to move the robot handle toward a moving or stationary target shown on the computer monitor. If the person starts moving in the wrong direction or does not move, the robotic arm gently nudges his or her arm in the right direction.

"The ability to be interactive is critical," says Krebs. "We program the robot to only give assistance as needed."

Patients in the study received therapy three times a week for 12 weeks, and during each hour-long session, they made hundreds of repetitive motions with their arms. At the end of 12 weeks, tests revealed a small but statistically significant improvement in quality of life, and a modest

improvement in arm function. When the subjects were tested again at 36 weeks, both the robot therapy group and intensive human-assisted therapy group showed improvement in arm movement and strength, everyday function and quality of life compared to the usual-care group.

The high-intensity, interactive physical therapy offered to patients who did not receive robot-assisted therapy was developed specifically for comparison purposes for this study, and is not generally available. Furthermore, the physical demands on the therapist make it unlikely that it will ever be widely used.

“If you can get a therapist to work at that pace with a patient, certainly the benefits are roughly the same, and we showed this benefit when we designed this intensive comparison group, but it’s not practical,” says Krebs. “Robotics and automation technology are ideal for this kind of highly repetitive tasks. We’re using robotic technology to create a tool for the therapist to afford this kind of high-intensity therapy while maintaining the therapist supervisory role, deciding what is right for a particular patient.”

This particular study was designed to test the effects of only conventional therapy versus only robotic therapy, but Bruce Dobkin, a neurologist at the UCLA Stroke Center, says the best approach may end up being a combination of those two strategies. “If robotic therapy is going to be helpful, you need to find a more integrated way to use the robotic device,” he says.

The value of robots

Another way to make robotic therapy more practical could be to lower the costs, says Dobkin, who was part of the data-safety monitoring committee that supervised the research. In the VA study, the robotic therapy cost an average of $9,977 per patient, and the intensive

nonrobotic therapy cost $8,269 per patient. However, overall healthcare per-patient costs, including costs for those who received only usual care, were not very different over the total 36-week study period — $15,562 per patient for robot-assisted therapy, $15,605 for intensive nonrobotic therapy, and $14,343 for usual care.

Krebs believes that once the robotic devices can be mass-produced, which he expects will occur within the next 10 years, the costs will drop. “What you have to do is make more of them, and that will drive down costs to a point where people can have them in their homes,” he says.

Krebs is also encouraged by the fact that many of the patients in the study had either suffered multiple strokes or had experienced their strokes many years earlier, yet still showed improvement. “We put the bar very high,” he says. “If we worked with patients sooner after their first stroke, we may get even better results.” He is now working with doctors to plan such a study.

Krebs and his collaborators are also studying whether the MIT-Manus could help patients with cerebral palsy, multiple sclerosis and spinal cord injury.

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