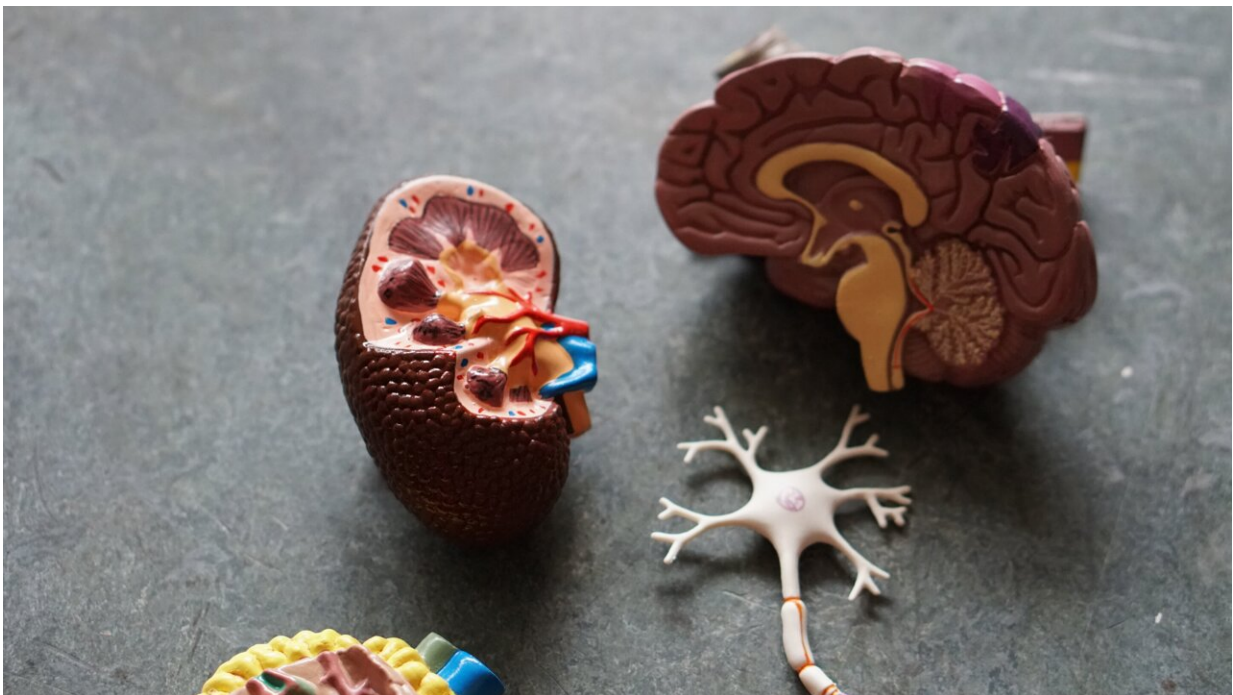# Noninvasive method for vagus nerve stimulation shows promise for enhancing motor rehabilitation after stroke

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Credit: Unsplash/CC0 Public Domain

The longest nerve in the human body starts in the brain and meanders its way down the neck and into the chest, where it splits into separate branches, winding its twisting tendrils to touch each internal organ. Known as the "information superhighway" and aptly named from the

Latin word meaning "wanders," the vagus nerve is a bundle of fibers responsible for the parasympathetic nervous system: digestion, heart rate, breathing.

Sending electrical impulses down this tenth cranial nerve has proven effective in treating conditions like depression and epilepsy, and it has shown great success in amplifying the effects of motor rehabilitation after stroke. Implanting a device onto the vagus nerve in the neck provides direct stimulation to the information superhighway. And using this technology during post-stroke motor rehabilitation was approved by the Food and Drug Administration as a treatment option in 2021.

But researchers at MUSC have found another method that accelerates treatment outcomes and improves motor function after stroke without this invasive and often-uninsured procedure.

As described in a recent paper from *Neurorehabilitation and Neural Repair*, the research team placed sensors on the upper arm and in the ear and used the connected computer to send timed electrical impulses to the vagus nerve during motor rehabilitation. This noninvasive VNS method, known as motor activated auricular vagus nerve stimulation (MAAVNS), allows patients to gain the same amount of motor function improvement in 4 weeks that patients with the implanted device reached in 6 weeks—all without surgery.

MAAVNS was developed and is currently pending patent at MUSC.

Stroke is a leading cause of disability in the United States according to the American Stroke Association, and it leads to motor deficits and reduced mobility in almost half of stroke survivors over the age of 65. With such a large number affected, Bashar Badran, Ph.D., the director of the Neuro-X lab and Computational Brain Imaging Core at MUSC as well as the principal investigator on the paper, wanted to find a more

accessible way to help patients recover.

"Motor rehabilitation is time-consuming and expensive, and oftentimes does not produce the results that patients want," said Badran. "Technology like the MAAVNS system can boost the effects of conventional motor rehabilitation and help patients get the most out of their therapy in a simple and relatively inexpensive manner. It's very exciting."

With a small cart containing the computer and sticker-like sensors, the MAAVNS system can easily be incorporated into occupational therapy settings, with little change or impact to the current standard of care.

With hundreds of repetitions in an hour, patients can focus on specific movements they want to improve, like sewing, cutting fabric or buttoning a shirt, while the MAAVNS system detects when the patient is moving and intricately delivers electrical stimulation to nerves in the ear.

Badran says delivering the stimulation in conjunction with each movement is critical. "Our work shows that outcomes are much better when you time the stimulation in conjuction with movement, in a closed-loop approach," he said. "Interestingly, more stimulation is not better. In fact, less stimulation timed correctly produces the best outcomes."

Since the vagus nerve elicits brain activity in areas responsible for the release of neurotransmitters like norepinephrine and serotonin which help the brain learn, stimulating it with electricity facilitates faster learning of motor skills.

While the sample size for this pilot study was small, Badran and his team will be conducting a larger clinical trial next to further study the effects of this noninvasive VNS technique.

"This is really promising technology," Badran said. "And the fact that the outcomes are mirroring what is already FDA approved is great. Not only do we believe this is an effective new technology for post-stroke motor rehabilitation, but it's cheaper and easier to incorporate into the standard of care than what is currently available."

More information: Bashar W. Badran et al, Motor Activated Auricular Vagus Nerve Stimulation as a Potential Neuromodulation Approach for Post-Stroke Motor Rehabilitation: A Pilot Study, *Neurorehabilitation and Neural Repair* (2023). DOI: 10.1177/15459683231173357

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