Biotech Innovations

Better Sensation and Dexterity for Artificial Hands

Today's standard prosthetic arms have a primitive hook that just opens and closes. Poor motor control coupled with a lack of sensation lead many people with limb loss to abandon their prostheses. A team of researchers is using sensory feedback to create a more dexterous bionic hand.

The group recently described the prototype LUKE arm—named after Luke Skywalker from *Star Wars*—in *Science Robotics*. They tested the device with a patient with a partial amputation below the left elbow. Sensors on the artificial hand communicated with an electrode array and electromyographic recording leads implanted in the patient's residual nerves and muscles of the amputated arm.

Electrode array stimulation of residual nerves evoked 119 sensations, which the patient described as vibration, pressure, or tapping, among others. With the system's closed-loop sensory feedback enabled, his grip precision, object discrimination, and ability to move objects without breaking them all improved. Finally, an algorithm developed to make artificial sensory signals mimic natural ones increased how quickly he could discriminate between soft or hard objects.

The patient, who lost his limb 14 years ago, also performed everyday activities with the prosthesis, including picking grapes, putting a pillowcase on a pillow, and shaking his wife's hand. He also reported less phantom limb pain and felt that the prosthetic arm was more a part of his body.

The researchers now plan to test a portable, take-home version of the system with more participants, according to the study's lead author, Jacob George, a graduate research fellow at the University of Utah in Salt Lake City.

Advances in Fluid Assessment and Kidney Injury Prediction

Chronic or acute hypervolemia affects more than 6 million US patients, but there's no practical way to precisely measure this harmful buildup of fluid to guide treatment. For patients undergoing hemodialysis, physicians typically rely on a physical examination and changes in body weight to monitor fluid status.

A technique called magnetic resonance imaging (MRI) relaxometry, while reliable, is expensive and unsuitable for routine use. Now, scientists have developed a portable magnetic resonance (MR) sensor that can be placed directly against the body, where it takes the same relaxometry measurements as a traditional MRI. It works faster and more cheaply than MRI machines by estimating extracellular fluid buildup from a single pixel instead of a whole image.

"Similar sensing methods have been used by the oil industry and by airport security [but] no one had yet applied this approach to the human body," said researcher Lina A. Colucci, PhD, of the Massachusetts Institute of Technology in Cambridge.

The 11-lb sensor costs around $1000. It detected fluid changes after dialysis in the lower legs of 5 patients with end-stage renal disease in a recent proof-of-concept study reported in *Science Translational Medicine*. The sensor performed comparably with bioimpedance measurements but, unlike the latter, factors such as sweat or electrode placement don't affect its readings. The MRI outperformed both bioimpedance and the MR sensor.

Next, Colucci's team wants to conduct a larger trial using a more sensitive version of the sensor that should detect early fluid overload with a single measurement, as was demonstrated with MRI. The work could open the door for many more portable, point-of-care MR diagnostics, she said.

Other work suggests that it also soon may be possible to continuously assess the risk of kidney injury in hospitalized patients, reducing the need for dialysis.

A new deep learning model predicted 55.8% of inpatient episodes of acute kidney injury up to 48 hours before they could be diagnosed clinically. The tool, recently described in *Nature*, also predicted 84.3% and 90.2% of kidney injuries that led to dialysis within 30 and 90 days, respectively. The model had a ratio of 2 false predictions for every true-positive prediction, but most of the false-positives were in patients with existing chronic kidney disease.

Researchers at the University College London, working with experts at the US Department of Veterans Affairs (VA), trained and tested the model using separate sets of electronic health records from more than 700 000 adult VA inpatients. The approach more accurately predicted acute kidney injury in men than in women, who comprised just more than 6% of the patients in the overall data set. Future training and evaluation are needed to address this limitation.

In an accompanying viewpoint, Eric Topol, MD, of the Scripps Research Translational Institute in La Jolla, California, said the model "stands out by providing a prediction that might enable effective clinical intervention." A fifth of post-admission acute kidney injury cases are avoidable, according to one estimate.

Although the researchers looked at acute kidney injury in this study, they suggested that deep learning approaches could be used to predict the risk of future patient deterioration across medical conditions. **– Jennifer Abbasi**

Note: Source references are available through embedded hyperlinks in the article text online.