Sensor could help patients stay on top of their meds

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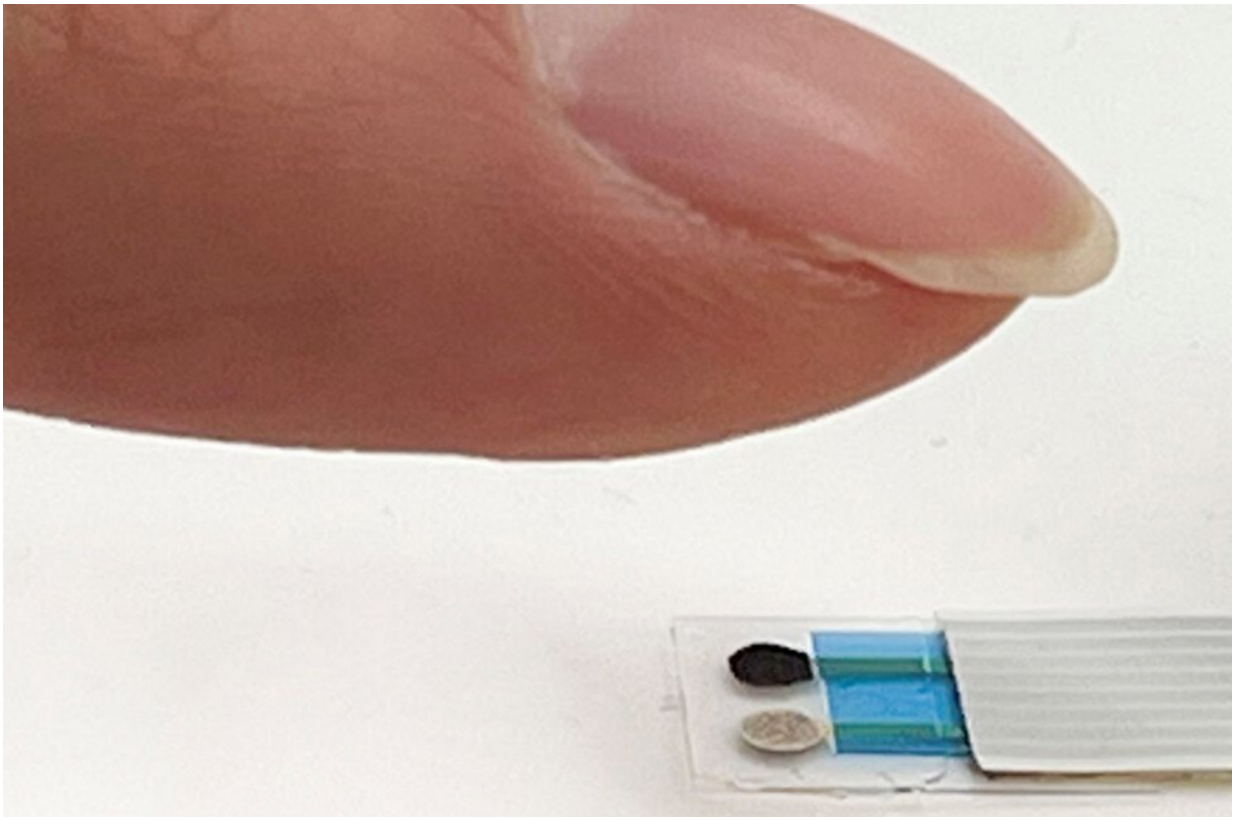

A tiny, touch-based sensor uses sweat to detect the level of lithium in the body. Credit: Jialun Zhu and Shuyu Lin

Lithium can alleviate the symptoms of bipolar disorder and depression—if taken in just the right amount. Too little won't work, while too much can bring on dangerous side effects. To precisely

monitor the amount of this medication in the body, patients must undergo invasive blood tests. But today, scientists report the invention of a tiny sensor that detects lithium levels from sweat on the surface of a fingertip in as little as 30 seconds, without a trip to the clinic.

The researchers will present their results today at the fall meeting of the American Chemical Society (ACS).

Not only must lithium be taken at a certain dosage, but patients often struggle to take it as prescribed and may miss pills. So, when the medication doesn't appear to be working, health care providers need to know how much medication the patient is actually swallowing. But current options for monitoring have significant drawbacks. For example, blood draws produce accurate results, but they are invasive and time consuming. Pill counters, meanwhile, don't directly measure the intake of the medication. To address these limitations, the team turned to another body fluid.

"Although it may not be visible, the human body constantly produces sweat, often only in very small amounts," says Shuyu Lin, Ph.D., a postgraduate student researcher who is co-presenting the work with graduate student Jialun Zhu at the meeting. "Small molecules derived from medication, including lithium, show up in that sweat. We recognized this as an opportunity to develop a new type of sensor that would detect these molecules."

"Through a single touch, our new device can obtain clinically useful molecular-level information about what is circulating in the body," says Sam Emaminejad, Ph.D., the project's principal investigator, who is at the University of California, Los Angeles (UCLA). "We already interact with a lot of touch-based electronics, such as smart phones and keyboards, so this sensor could integrate seamlessly into daily life."

Devising a sensor to detect lithium presented some technical challenges, however. Sweat is generally only present in minute amounts, but the electrochemical sensing needed to detect charged particles of lithium required an aqueous, or watery, environment. To provide it, the team engineered a water-based gel containing glycerol. This extra ingredient prevented the gel from drying out and created a controlled environment for the electronic portion of the sensor.

To trap the lithium ions after they traversed the gel, the team used an ion-selective electrode. The accumulating ions generate a difference in electrical potential compared with a reference electrode. The researchers used this difference to infer the concentration of lithium present in sweat. Together, these components comprise a tiny, rectangular sensor that is smaller than the head of a thumbtack and can detect lithium in about 30 seconds. The sensor is still in the preliminary testing phase, but ultimately, the researchers envision incorporating it into a larger, yet-to-be designed system that provides visual feedback to the provider or the patient.

After characterizing the sensor using an artificial fingertip, the team recruited real people to test it, including one person on a lithium treatment regimen. The researchers recorded this person's lithium levels before and after taking the medication. They found that these measurements fell close to those derived from saliva, which prior research has shown to accurately measure lithium levels. In the future, the researchers plan to study the effects of lotion and other skin products on the sensor's readings.

This technology also has applications beyond lithium. Emaminejad is developing similar touch-based sensors to monitor alcohol and acetaminophen, a painkiller also known as Tylenol, while also exploring the possibility of detecting other substances. The complete sensing systems could include additional features, such as encryption secured by

a fingerprint, or, for substances prone to abuse, a robotic dispensing system that releases medication only if the patient has a low level in their bloodstream.

More information: Touch-based non-invasive lithium monitoring using an organohydrogel-based sensing interface, ACS Fall 2022. www.acs.org/content/acs/en/mee … tings/fall-2022.html

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