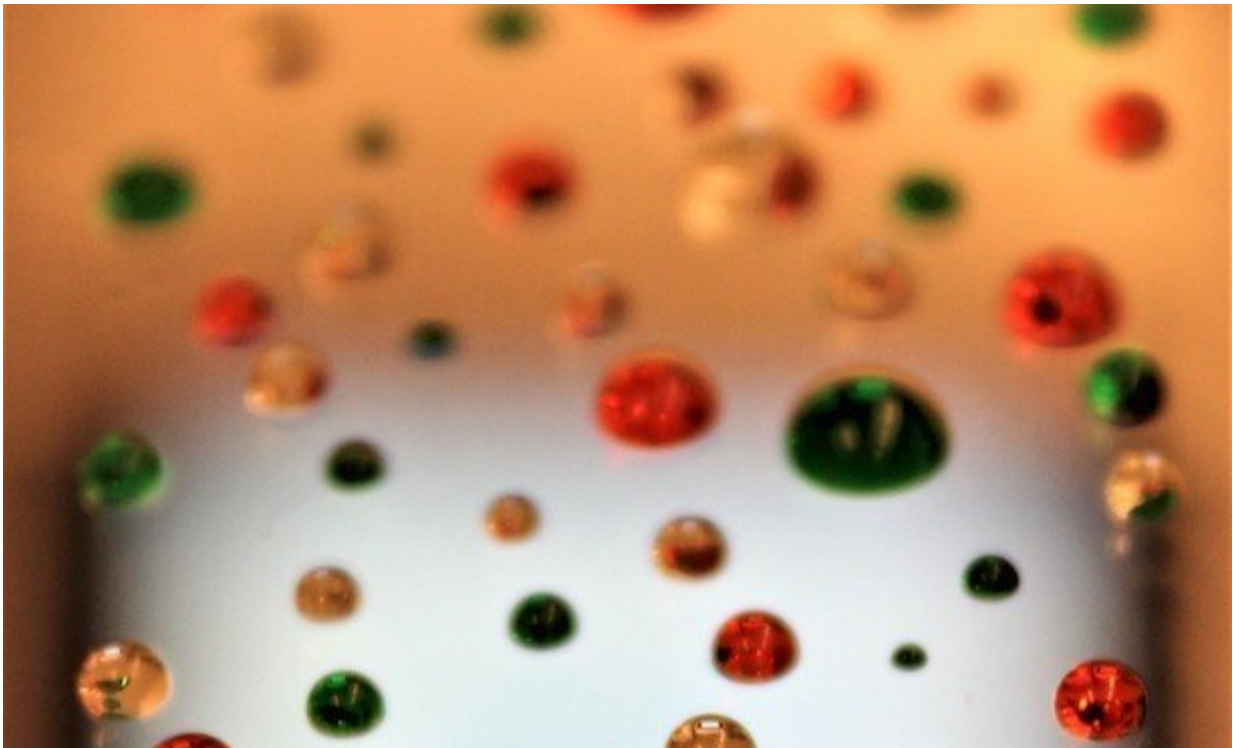


New urine testing method holds promise for kidney stone sufferers

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A bioinspired technology enables machine-free droplet manipulation for potential rapid diagnostic urine testing for kidney stone patients. Credit: provided by Pak Kin Wong, Penn State

An improved urine-testing system for people suffering from kidney stones inspired by nature and proposed by researchers from Penn State and Stanford University may enable patients to receive results within 30

minutes instead of the current turnaround time of a week or more.

Kidney stones occur due to buildup of certain salts and minerals that form crystals, which in turn stick together and enlarge to form a hard mass in the kidneys. The stones move into the [urinary tract](#) and can cause blood in the urine, considerable pain and blockages in the urinary system.

Metabolic testing of a kidney [stone](#) patient's urine to identify metabolites such as minerals and solutes that cause stones to form is key for preventing future ones. This testing is currently done by requiring the patient to collect their urine over a [24-hour period](#) in a large container. The container is then sent to a lab for analysis and the results normally come back in 7 to 10 days.

"The lengthy process, cumbersome collection procedure and delay in obtaining the results render 24-hour urine testing to be underutilized in [clinical practice](#) despite guideline recommendations," said Pak Kin Wong, professor of biomedical engineering and mechanical engineering and principal investigator on the study. The research was published today in *Science Advances*.

Wong said that expensive special equipment is required to detect urinary solutes and minerals for a test result. The [urine sample](#), therefore, has to be shipped to a commercial diagnostic lab for testing. To solve this, the research team developed a biomimetic detection system called slippery liquid-infused porous surface (SLIPS)-LAB.

SLIPS is a dynamic, extremely low-friction smooth surface created by locking lubricating liquids in micro/nanostructured substrates. This is inspired by nepenthes pitcher plants, which are [carnivorous plants](#) that have unique leaves shaped like pitchers and are filled with digestive liquid. The plants have evolved extremely slippery liquid-infused micro-

textured rims that cause insects to fall into the "pitcher."

"There are many aspects we can learn from nature and our environment, and our research is an example how biomedical engineers can make good use of it," Wong said.

SLIPS-LAB works by enabling reagent and urine droplets to easily move over the slick surface of the testing device's fluid addition channel and not get stuck. The droplet is driven by a Laplace pressure difference, a small pressure force due to surface tension, induced by the geometry of the device. This enables the reactants to combine with the urine at the necessary timed rate for reaction.

"We demonstrated that SLIPS-LAB enables the reagent and sample to move themselves and perform the reactions for us," Wong said. "It means the technology doesn't require a technician to run any test machinery, so it is possible to do the test in non-traditional settings, like a physician's office or even the patient's home."

The test results can then be read using a scanner or a cell phone, and the scanned image can then be analyzed using a computer algorithm. All these steps, according to Wong, would take approximately 30 minutes in a physician's office. An added benefit, Wong said, is that SLIPS-LAB is more cost-effective than regular, 24-hour testing.

"The low cost, rapidity and simplicity of SLIPS-LAB would reduce the barrier for the clinician and patient to undergo stone risk metabolite analysis," Wong said. "This would improve the management of patients with urinary stone disease and open new possibilities for stone patients to test their urine samples in mobile health settings."

The lead author of the study, Hui Li, graduate student in biomedical engineering, said another promising result of their research was

demonstrating that the test also works as a spot test, which means a patient can monitor certain levels in their [urine](#) without 24-hour collection.

"SLIPS-LAB may open new opportunities in on-demand monitoring of urinary analytes and may potentially transform metabolic evaluation and clinical management of urinary stone disease," Li said.

More information: "SLIPS-LAB—A bioinspired bioanalysis system for metabolic evaluation of urinary stone disease" *Science Advances* (2020). advances.sciencemag.org/content/6/21/eaba8535

Provided by Pennsylvania State University

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