# Engineers develop the 'potalyzer,' a roadside saliva test for marijuana intoxication

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Stanford engineers are developing a portable device that measures THC levels in saliva, a step toward creating a roadside test for driving under the influence of marijuana. Credit: Reuters/Rick Wilking

This November, several states will vote whether to legalize marijuana use, joining more than 20 states that already allow some form of cannabis use. This has prompted a need for effective tools for police to determine on the spot whether people are driving under the influence.

Stanford researchers have devised a potential solution, applying

magnetic nanotechnology, previously used as a cancer screen, to create what could be the first practical roadside test for marijuana intoxication.

While police are trying out potential tools, no device currently on the market has been shown to quickly provide a precise measurement of a driver's marijuana intoxication as effectively as a breathalyzer gauges alcohol intoxication. THC, the drug's most potent psychoactive agent, is commonly screened for in laboratory blood or urine tests – not very helpful for an officer in the field.

The Stanford device might function as a practical "potalyzer" because it can quickly detect not just the presence of THC in a person's saliva, but also measure its concentration.

Led by Shan Wang, a professor of materials science and engineering and of electrical engineering, the Stanford team created a mobile device that uses magnetic biosensors to detect tiny THC molecules in saliva. Officers could collect a spit sample with a cotton swab and read the results on a smartphone or laptop in as little as three minutes.

Researchers tackling the "potalyzer" problem have zeroed in on saliva because testing it is less invasive and because THC in saliva may correlate with impairment better than THC in urine or blood. The big challenge is that these spit tests may be called upon to detect superlatively tiny concentrations of THC. Some states have no set limit of THC in the body for drivers, while others set a limit of 0 or 5 nanograms (a billionth of a gram) per milliliter of blood.

Wang's device can detect concentrations of THC in the range of 0 to 50 nanograms per milliliter of saliva. While there's still no consensus on how much THC in a driver's system is too much, previous studies have suggested a cutoff between 2 and 25 ng/mL, well within the capability of Wang's device.

## Repurposing biomedical tools

The researchers achieved such precision by harnessing the behavior of magnetism in nanoparticles, which measure just a few tens of billionths of a meter.

The Wang Group has been exploring magnetic nanotechnology for years, using it to attack such diverse problems as in vitro cancer diagnostics and magnetic information storage. In this case, they're combining magnetic nanotechnology with the time-tested biochemical technique of the immunoassay. Immunoassays detect a certain molecule in a solution by introducing an antibody that will bind only to that molecule.

In the test, saliva is mixed with THC antibodies, which bind to any THC molecules in the sample. Then the sample is placed on a disposable chip cartridge, which contains magnetoresistive (GMR) sensors pre-coated with THC, and inserted into the handheld reader.

This sets in motion a "competition" between the THC pre-coated on the sensor and THC in the saliva to bind with the antibodies; the more THC in the saliva, the fewer antibodies will be available to bind to the THC on the sensor surface.

The number of antibodies bound to THC molecules on the sensor tells the device how many antibodies the THC in the sample used up, and therefore how many THC molecules were present in the sample.

Next, magnetic nanoparticles, specially made to bind only to the antibodies, are introduced to the sample. Each nanoparticle binds onto a THC-antibody pair like a sticky beacon, but only the molecules on the sensor surface will be close enough to trip the GMR biosensors in the reader. The device then uses Bluetooth to communicate results to the screen of a smartphone or laptop.

"To the best of our knowledge, this is the first demonstration that GMR biosensors are capable of detecting small molecules," Wang wrote in a paper describing the device, published in *Analytical Chemistry*.

## Beyond marijuana

The platform has potential usefulness beyond THC. Just as they do with THC, the GMR biosensors in the device could detect any small molecule, meaning that the platform could also test for morphine, heroin, cocaine or other drugs.

In fact, with 80 sensors built into it, the GMR biosensor chip could screen a single sample for multiple substances. The team has already tried screening for morphine with promising results.

Students are currently working on creating a user-friendly form factor for the device, which would need to go through field tests and be approved by regulators before it can be deployed by police.

Another thing that would have to happen before the device would be useful to law enforcement: State laws must set limits for the concentration of THC allowed in a driver's saliva.

Here too, the Wang Group's device could be helpful. For example, the next generation of the device could screen both the blood and saliva of a subject to establish an understanding of the correlation between blood THC level and saliva THC level at the same degree of intoxication.

Provided by Stanford University

roadside-saliva-marijuana-intoxication.html