Researchers use laser, nanotechnology to rapidly detect viruses

Waiting a day or more to get lab results back from the doctor's office soon could become a thing of a past. Using nanotechnology, a team of University of Georgia researchers has developed a diagnostic test that can detect viruses as diverse as influenza, HIV and RSV in 60 seconds or less.

In addition to saving time, the technique – which is detailed in the November issue of the journal Nano Letters – could save lives by rapidly detecting a naturally occurring disease outbreak or bioterrorism attack.

"It saves days to weeks," said lead author Ralph Tripp, Georgia Research Alliance Eminent Scholar in Vaccine Development at the UGA College of Veterinary Medicine. "You could actually apply it to a person walking off a plane and know if they're infected."

The technique, called surface enhanced Raman spectroscopy (SERS), works by measuring the change in frequency of a near-infrared laser as it scatters off viral DNA or RNA. This change in frequency, named the Raman shift for the scientist who discovered it in 1928, is as distinct as a fingerprint.

This phenomenon is well known, but Tripp explained that previous attempts to use Raman spectroscopy to diagnose viruses failed because the signal produced is inherently weak.

But UGA physics professor Yiping Zhao and UGA chemistry professor Richard Dluhy experimented with several different metals and methods and found a way to significantly amplify the signal. Using a method they've patented, they place rows of silver nanorods 10,000 times finer than the width of a human hair on the glass slides that hold the sample. And, like someone positioning a TV antenna to get the best reception, they tried several angles until they found that the signal is best amplified when the nanorods are arranged at an 86-degree angle.

"The enhancement factors are extraordinary," Dluhy said. "And the nice thing about this fabrication methodology is that it's very easy to implement, it's very cheap and it's very reproducible."

Tripp said the technique is so powerful that it has the potential to detect a single virus particle and can also discern virus subtypes and those with mutations such as gene insertions and deletions. This specificity makes it valuable as a diagnostic tool, but also as a means for epidemiologists to track where viruses originate from and how they change as they move through populations.

The researchers have shown that the technique works with viruses isolated from infected cells grown in a lab, and the next step is to study its use in biological samples such as blood, feces or nasal swabs. Tripp said preliminary results are so promising that the researchers are currently working to create an online encyclopedia of Raman shift values. With that information, a technician could readily reference a Raman shift for a particular virus to identify an unknown virus.

To make their finding commercially viable, they're developing a business model, seeking venture capital and exploring ways to mass produce the silver nanorods. Next year, they plan on moving their enterprise to the Georgia BioBusiness Center, an UGA incubator for startup bio-science companies.

Presently, viruses are first diagnosed with methods that detect the antibodies a person produces in response to an infection. Tripp explained that these tests are prone to false positives because a person can still have antibodies in their system from a related infection decades ago. The tests are also prone to false negatives because some people don't produce high levels of antibodies.

Because of these limitations, antibody based tests often must be confirmed with a test known as polymerase chain reaction (PCR), which detects the virus itself by copying it many times. The test can take anywhere from several days to two weeks. Tripp said the latter is clearly too long, especially in light of emerging threats such as H5N1 avian influenza.

"For some respiratory viruses, you've either cleared the infection at that point or succumbed to the infection," Tripp said. "What we've developed is the next generation of diagnostic testing."

Source: University of Georgia