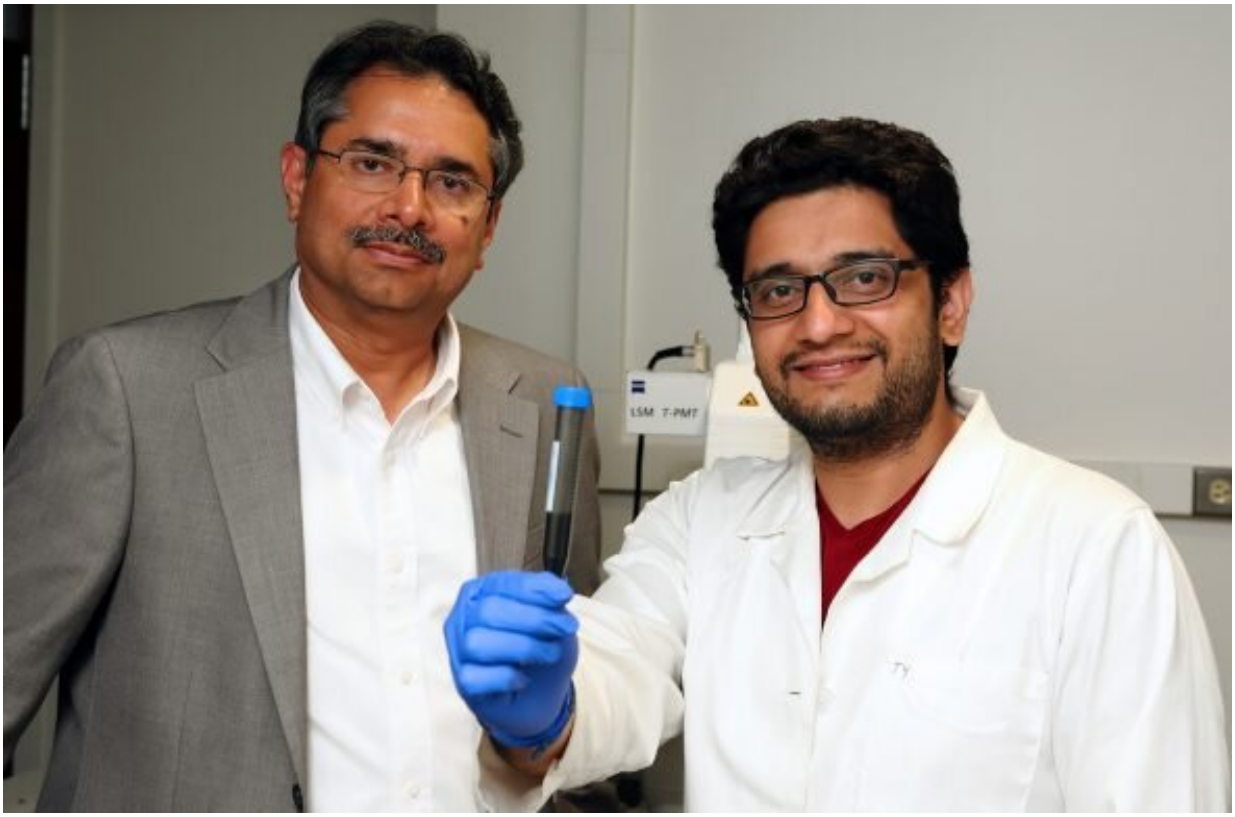
Charcoal-based drug delivery system improves efficacy of common herpes drug

August 14 2019, by Sharon Parmet



Deepak Shukla and Tejabhiram Yadavalli. Credit: Jenny Fontaine.

A study led by researchers from the University of Illinois at Chicago has found that combining acyclovir—a commonly prescribed topical herpes medication—with particles of activated carbon improves efficacy of the

drug. This new approach allows for less frequent dosing and overall course of treatment while providing some protection from infection by the virus as well, opening up the possibility of using the combination in prophylactic products.

The findings of the study are reported in the journal *Science Advances*.

"Combing herpes medication with activated charcoal makes the drug much more efficient so less of the drug is needed to achieve the same effect," said Deepak Shukla, the Marion Schenk Professor of Ophthalmology and professor of microbiology and immunology in the UIC College of Medicine and the senior author of the paper. "Using less of the drug can help reduce the risk for kidney damage, which can be significant when these drugs are used over long periods of time."

There are two types of herpes simplex virus: herpes simplex 1, which infects the eyes and mouth and is a leading cause of blindness, and herpes simplex 2, a genital infection that causes warts and can seriously impair quality of life.

Treatment for both infections often includes acyclovir—a systemic medication taken orally. However, long-term use often results in resistance to the drug as well as kidney damage. Activated carbon is known to have purifying effects by trapping toxins in its highly porous structure. Particles tend to bind to charcoal easily and it is often used in filters for water for this reason.

Shukla and his colleagues looked at the effect of both plain activated carbon and activated carbon plus acyclovir on HSV-1 and HSV-2.

Dilutions of plain activated carbon were able to reduce the infection of cells in the lab when applied to the cells prior to exposure to HSV-1 or HSV-2. They saw a 4% to 60% reduction in infections compared with

when they exposed the cells to the virus without activated carbon present.

When they combined acyclovir with activated carbon and tested the mixture in mice infected with either HSV-1 or HSV-2, applying it to either the eyes or genitals, they saw that it was more effective and faster at reducing inflammation and viral load than topical or systemic acyclovir alone. Additionally, they found that the drug seemed to be working much more efficiently when combined with activated carbon, and they could achieve the same reductions in viral load and inflammation using far fewer doses than with acyclovir alone.

"We think that the charcoal releases particles of acyclovir slowly over time because the herpes virus, as well as other organic molecules and particles, are more attracted to the charcoal than the drug, and as these particles interact with the charcoal they displace and release the drug," said Tejabhiram Yadavalli, a postdoctoral fellow studying herpes viruses at UIC and a co-inventor of the technology. "The activated carbon acts like a slow-release drug capsule. Because it likes to bind with the virus, this gives it additional anti-viral properties."

Yadavalli and Shukla call the charcoal delivery system DECON for Drug Encapsulated Carbon.

"Activated carbon is known to be safe for use by humans and has been used for thousands of years for its purifying properties. We think that using it as a novel drug delivery system could help reduce dosing, cost and risk of toxicity to the kidneys and could eventually be used in lubricants prophylactically to help prevent new HSV genital infection," Shukla said.

More information: "Drug-encapsulated carbon (DECON): A novel platform for enhanced drug delivery" *Science Advances* (2019). DOI:

10.1126/sciadv.aax0780 ,
advances.sciencemag.org/content/5/8/eaax0780