'Smart capsule' is potential new drug-delivery vehicle

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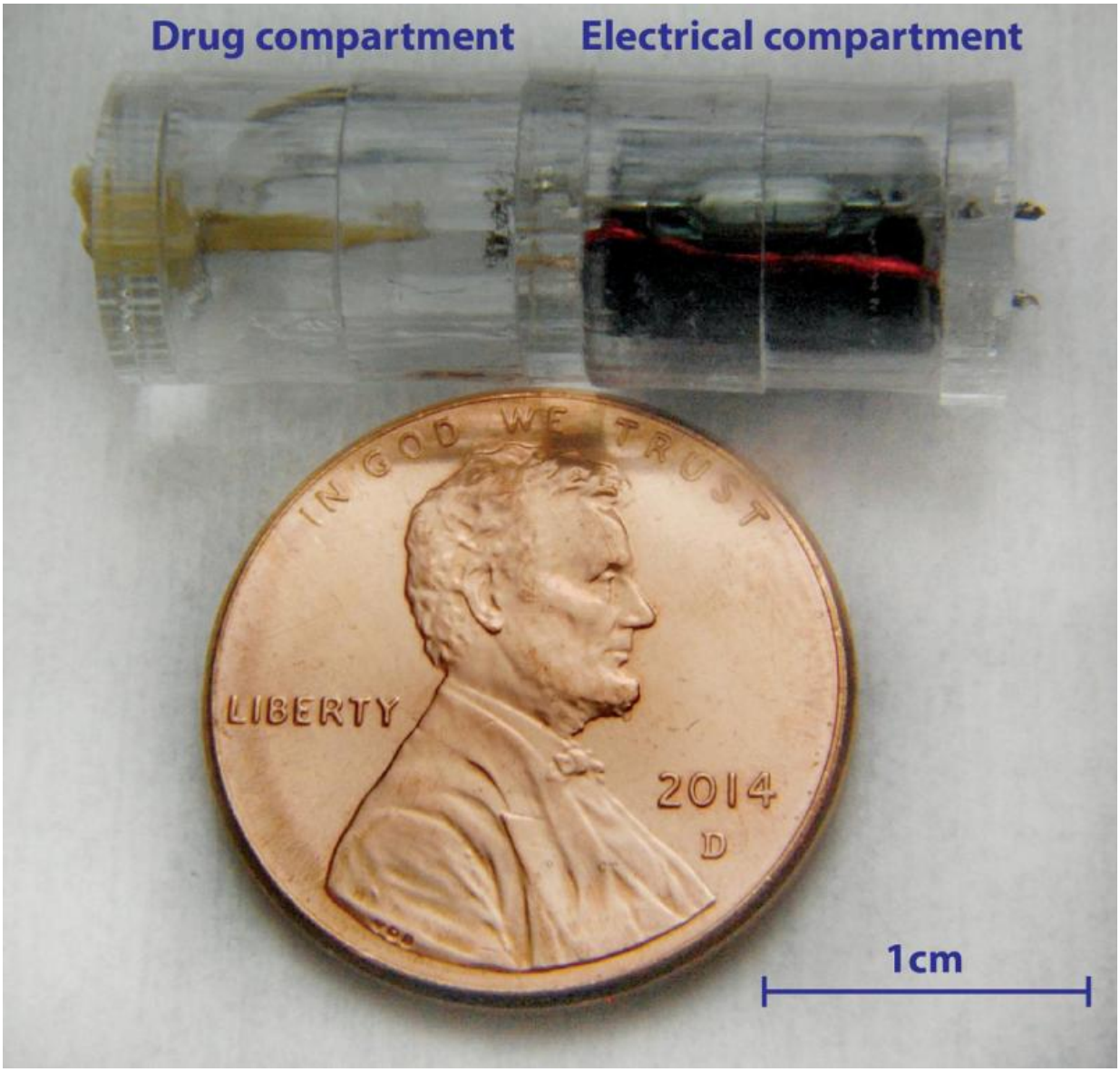


A new "smart capsule" under development could deliver medications directly to

the large intestines to target certain medical conditions. The prototype is about as large as a 000-size gelatin capsule. Credit: Purdue University/Babak Ziaie

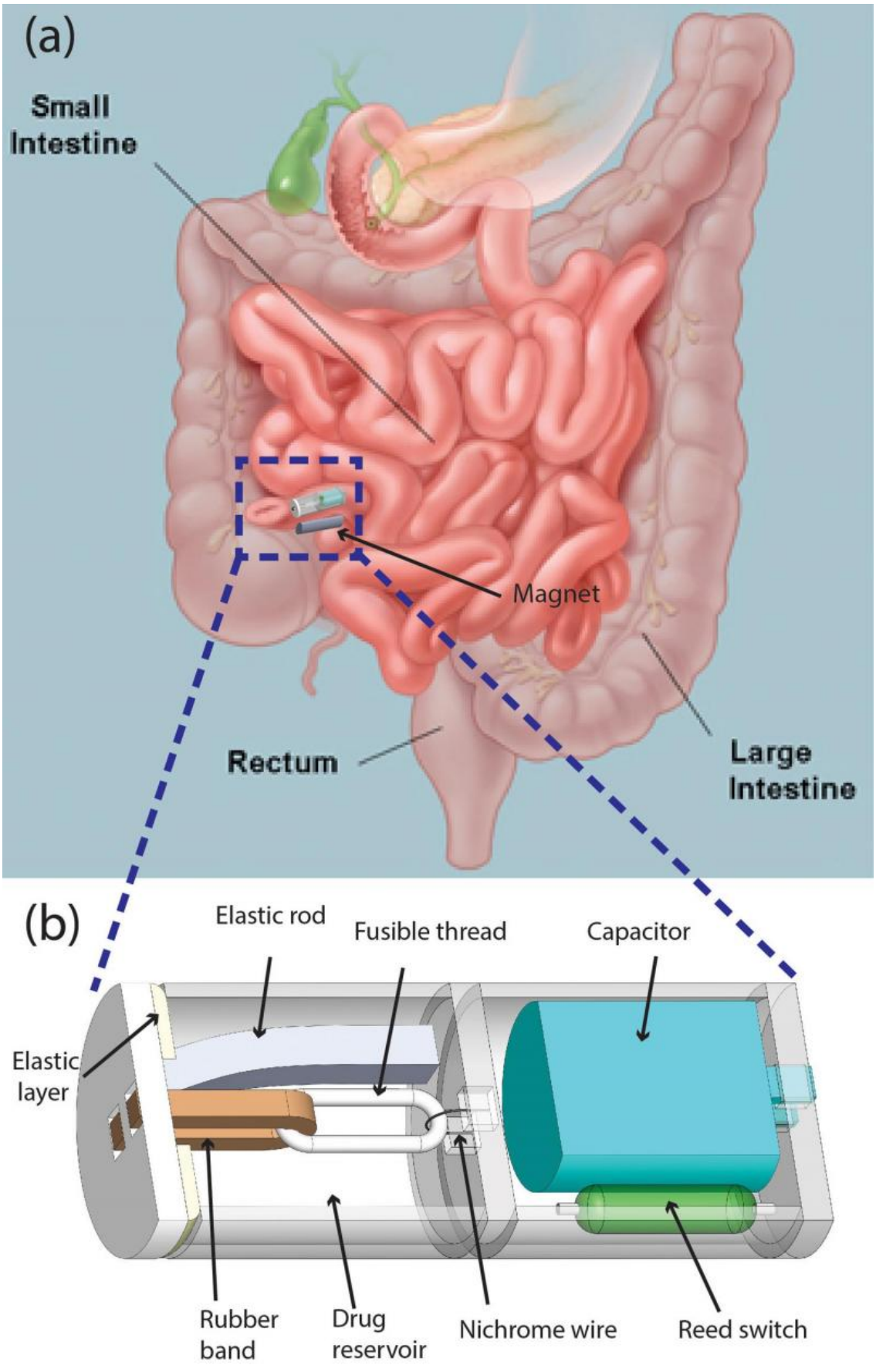
A new "smart capsule" under development could deliver medications directly to the large intestines to target certain medical conditions.

"Usually, when you take medication it is absorbed in the stomach and small intestine before making it to the large intestine," said Babak Ziaie, a professor of electrical and computer engineering at Purdue University. "However, there are many medications that you would like to deliver specifically to the large intestine, and a smart capsule is an ideal targeted-delivery vehicle for this."

Such an innovation might be used to treat of irritable bowel syndrome, Crohn's disease and a potentially life-threatening bacterial infection called Clostridium difficile in which the body loses natural microorganisms needed to fight infection.

Findings are detailed in a research paper that appeared online and will be published in a future print issue of the Institute of Electrical and Electronics Engineers (IEEE) *Transactions of Biomedical Engineering*. The paper was authored by graduate students Wuyang Yu, Rahim Rahimi and Manuel Ochoa; Rodolfo Pinal, an associate professor of industrial and physical pharmacy; and Ziaie.

People are sometimes treated for C. difficile by transplanting feces from another person into the patient's large intestine, which provides vital microbes. However, it might be possible to convert the microbes into a powder through freeze-drying and deliver them with smart capsules instead, Ziaie said.


(a)
Small Intestine
Magnet
Rectum
Large Intestine
(b)
Elastic rod
Fusible thread
Capacitor
Elastic layer
Rubber band
Drug reservoir
Nichrome wire
Reed switch

The smart pill is designed to release powdered medication just before reaching the ileocecal valve, where the small and large intestine meet. Credit: Purdue University/Babak Ziaie

Researchers tested the smart capsule with a "fluidic model" that mimics the gastrointestinal tract and also using an experiment that recreates the changing acidity and peristalsis of the stomach and intestines as food passes through the digestive system.

"It takes up to 12 hours to get to the large intestine, so we wanted to make sure the smart capsule can withstand conditions in the gastrointestinal tract," Ziaie said.

The capsule is powered by a capacitor that is charged before use. A switch inside the capsule is activated by a magnet that could be worn on the patient's waist. As the capsule meanders through the intestines it eventually comes close to the magnet, activating the switch and releasing a spring-loaded mechanism that opens the capsule, which delivers the medication.

The prototype capsule is about the same size as a 000-size gelatin capsule and is designed to release the powdered medication just before reaching the ileocecal valve, where the small and large intestines meet.

The researchers have filed for a provisional U.S. patent through Purdue's Office of Technology Commercialization of the Purdue Research Foundation.

The research is ongoing and is based at Purdue's Birck Nanotechnology

Center. Future work may involve human patients.

More information: A Smart Capsule with GI-Tract-Location-Specific Payload Release, *Transactions of Biomedical Engineering*, 2015.

Provided by Purdue University