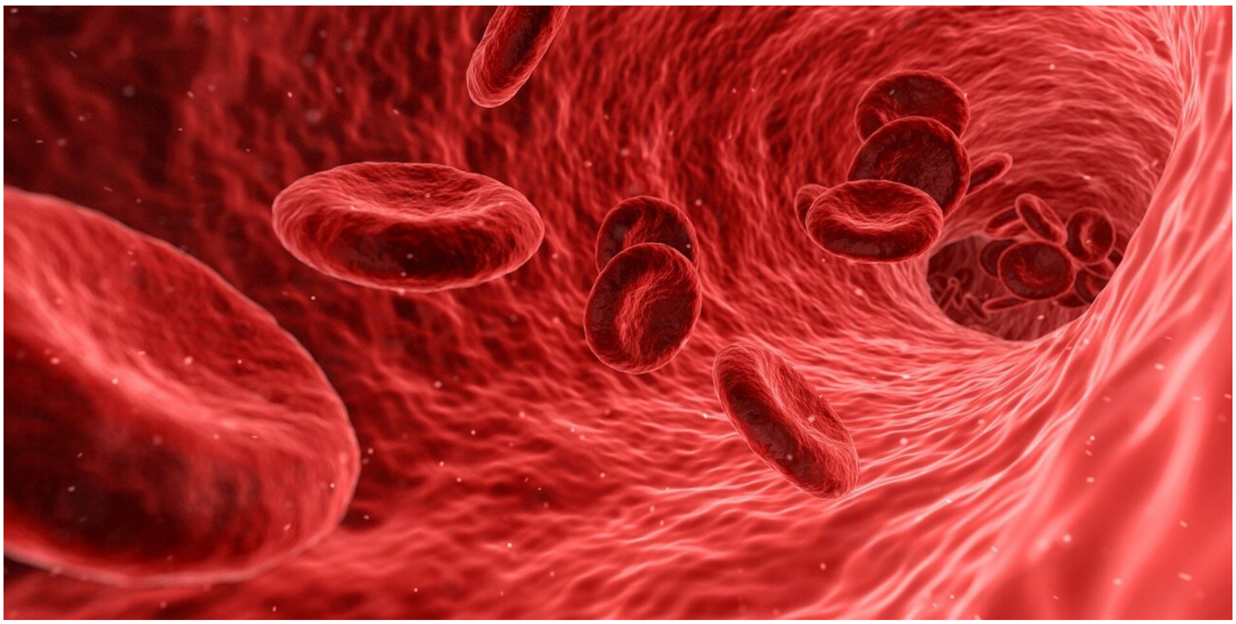
Microscopic bots treat blood clots and more

October 8 2019, by Amy Ventura



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Technically, they're called "microwheels," but you can call them "blood bots."

No matter what you call them, they're microscopic work-performing devices that are injected into tubes to break up obstructions and clear the passageway. And they could help people with blood clots, stroke, cystic fibrosis and more.

Since 2014, Professor of Bioengineering and Pediatrics Keith Neeves, Ph.D., and his research team in the Department of Bioengineering have been developing these magnetically powered bots to be used in medical treatment.

"From an engineer's perspective, it's a practical transport issue," Neeves said of his high-tech research funded by the National Institutes of Health. "There's a pipe with a blockage, and you've got to get the flow going again. We're essentially plumbers trying to clear a clogged pipe."

Why we need blood bots

There's a mantra among health care providers who deal with stroke: Time is brain.

"Strokes are caused by blood clots that block blood flow to the brain. The longer the brain is without blood, [and consequently oxygen,] the more damage is caused, and the more brain function may be lost," said Neeves, a long-time chemical engineer who came to the College of Engineering, Design and Computing in March 2019.

The catheters used to fish out large-vessel clots won't fit in small vessels, so the current treatment for small-vessel clots is an intravenously injected, clot-dissolving medication. But that drug has limitations.

Since there's no blood flow when there's a clot, it's difficult and time-consuming for the drug to move through the vessel to reach the clot. The drug can cause bleeding, so can't be used in high concentrations. And finally, it must be used within 4-6 hours of the onset of the stroke.

"We're hoping to extend that window with this technology," Neeves said. "We're injecting less of the drug but in a way that results in a higher concentration at the site of the clot."

How a bot dissolves a blood clot

In collaboration with colleagues at CU Anschutz, Colorado School of Mines and the University of Michigan, Neeves has been working to develop bots to dissolve small-vessel blood clots 10 times faster than the current treatment.

Each tiny bot is about the size of a blood cell. For reference, that's 50 times smaller than a human hair.

A bunch of these bots are coated with the clot-dissolving drug and injected into the blood stream of a patient. Once inside, they're controlled via magnetic fields outside the body and driven as quickly as possible to the clot site.

The bots have paramagnetic properties—meaning their attraction to magnetic poles is weak—so they can be formed into a chain, which can then be shaped into a disc or wheel. Because wheels move by rolling, the microwheels can move much more quickly than most other microbots, which swim.At the clot site, the drug-laced blood bots dissolve the clot, a process called thrombolysis. When their work is done, the magnetic field is removed, allowing the bots to disassemble into individual particles that can be metabolized by the liver.

Help for one in four stroke victims

The blood bot process sounds simple enough. The challenge is navigation and imaging, Neeves said.

It's hard to drive microscopic particles through a complex network of tubes—i.e. the human body's millions of vessels and arteries. And it's even harder when you can't see where you're driving—since our bodies aren't transparent.But it's worth trouble shooting, given that small-vessel strokes—called ischemic strokes—account for 25 percent of all strokes. So, the treatment would help a quarter of all stroke patients. And its applications could open up to help people with cystic fibrosis whose airways become blocked with mucus.

When engineers practice medicine

Most people are surprised when they learn that Neeves, who runs a hematology research lab, is an engineer by trade. But applying his engineering skills to the field of health care opens the door to powerful discoveries.

"Many problems in medicine are technological ones, so engineers can have a lot of impact," said Neeves, who came to the university to find opportunities to further interface engineering with medicine. "You want a diverse set of skills and perspectives at the table—we [engineers] bring that."

In his lab, knowledge from various disciplines intersects to create big ideas—and he loves that.

"I really enjoy bringing engineering science to medicine and the end users, physicians and other care providers," he said.

Provided by University of Colorado Denver

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