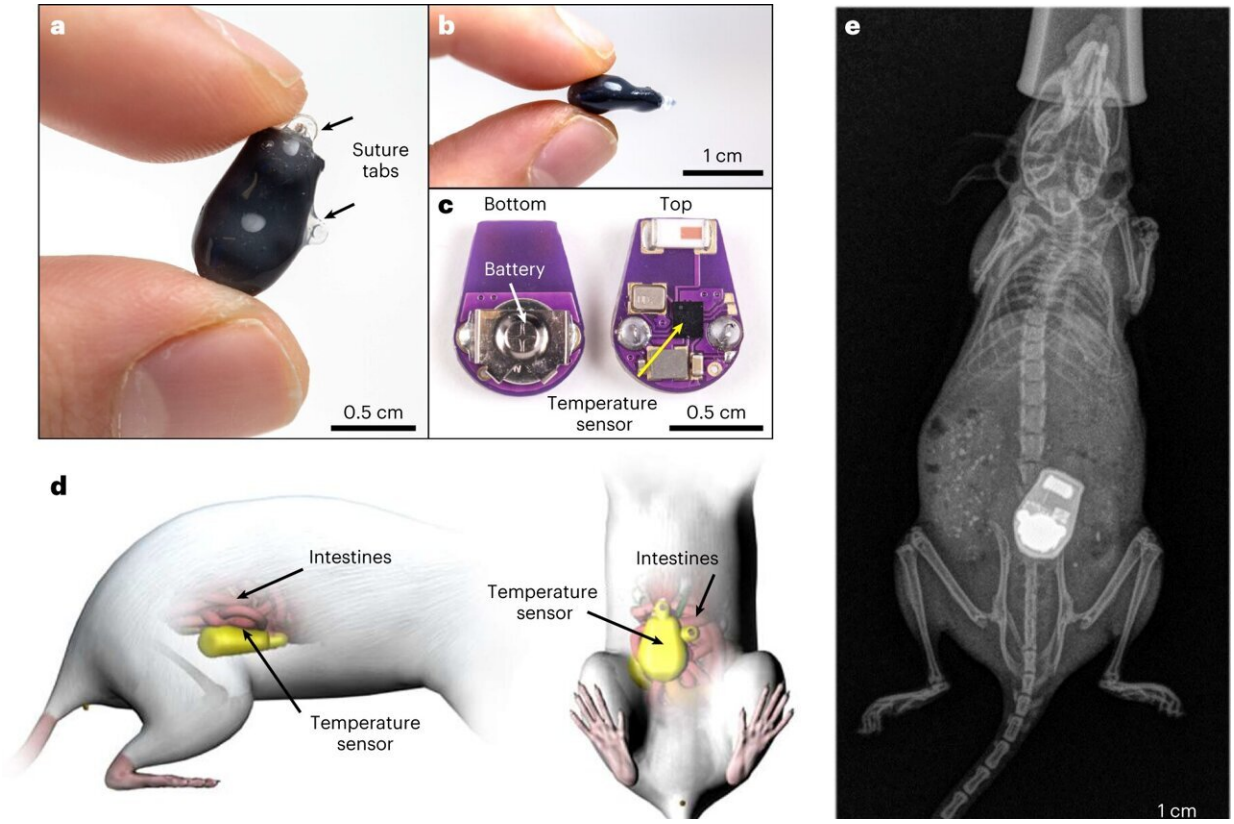
Implantable sensor could lead to timelier Crohn's treatment

March 18 2024



Implantable temperature sensors for monitoring Crohn's-disease-like ileitis and their use in studies in mouse models. Credit: *Nature Biomedical Engineering* (2024). DOI: 10.1038/s41551-024-01183-w

A team of Northwestern University scientists has developed the first wireless, implantable temperature sensor to detect inflammatory flareups

in patients with Crohn's disease. The approach offers long-term, real-time monitoring and could enable clinicians to act earlier to prevent or limit the permanent damage caused by inflammatory episodes.

More than 1 million Americans have Crohn's disease, a chronic inflammatory bowel disease that affects the intestines, causes digestive issues and can lead to weight loss, malnutrition and other complications. People with mild cases are treated with oral medications, but these drugs typically fail over time, requiring approximately 70% of Crohn's patients to undergo at least one surgery to remove portions of damaged intestines.

Because heat is indicative of inflammation, the Northwestern scientists tested whether a temperature sensor resting gently against the intestines of mice with Crohn's disease could provide real-time insight into the progression of the disease, as well as detect episodic flareups. Sure enough, they accomplished both goals in their research, which was published, in a paper titled "Miniaturized implantable temperature sensors for the long-term monitoring of chronic intestinal inflammation," in the journal *Nature Biomedical Engineering.*

Arun Sharma, whose group led the animal testing, said there is currently no way for clinicians to quickly detect inflammatory events, some of which go unnoticed by patients until the problem becomes so severe that it requires invasive surgery.

"The magnitude of the flareup can be measured with regards to the heat signature," said Sharma, co-corresponding author on the paper and a research associate professor of urology at Northwestern University Feinberg School of Medicine and of biomedical engineering at McCormick School of Engineering. "Is it so extensive that it's going to cause tissue damage over time?

"This could be potentially prevented if a clinician has this information

readily at hand and can determine what type of therapy can be given to that person at that moment in time, rather than waiting weeks to get a blood analysis, tissue biopsy or fecal analysis. In the meantime, you're losing valuable minutes regarding tissue damage with this inflammatory event."

Sharma said this strategy of measuring temperature fluctuations could also be useful for patients with ulcerative colitis, another inflammatory bowel disease, or any condition where there is a prolonged inflammatory response. In their study, the researchers used the wireless sensors to continuously track temperature fluctuations for nearly four months.

Bioelectronics pioneer John Rogers, whose group led the device development, published another paper describing an ultrathin, soft implant that measures temperature and perfusion changes as a way to monitor the health of transplanted organs. Once again, the relationship between heat and inflammation was key, as excess inflammation around the transplanted organ can offer an early warning sign that the new organ is being rejected by the patient's immune system.

"To address Crohn's disease, we developed an ultraminiaturized, precision temperature sensor with wireless communication capability," said Rogers, co-corresponding author on the paper.

"This tiny, soft device takes the form of a smooth, round capsule that rests within the GI system, without affecting natural physiological processes for long-term recordings. The data show some very unique signatures, in the form of perturbations to natural circadian cycles, known as ultradian rhythms, as early indications of inflammatory responses."

The scientists discovered that the ultradian temperature rhythms correlate to cyclic variations in stress levels and inflammatory markers in

blood, said Surabhi Madhvapathy, co-first author from Rogers group who led the sensor engineering.

"In addition to the short-term variations, we learned over the span of weeks to months, that the average temperature of the intestines decreases," Madhvapathy said. "This decrease was indicative of the worsening tissue quality over time."

Following these successful results in mice, the researchers plan to assess the sensor capabilities in human tissues that recreate the inflammatory gut conditions found in Inflammatory Bowel Disease.

More information: Surabhi R. Madhvapathy et al, Miniaturized implantable temperature sensors for the long-term monitoring of chronic intestinal inflammation, *Nature Biomedical Engineering* (2024). DOI: 10.1038/s41551-024-01183-w

Provided by Northwestern University

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