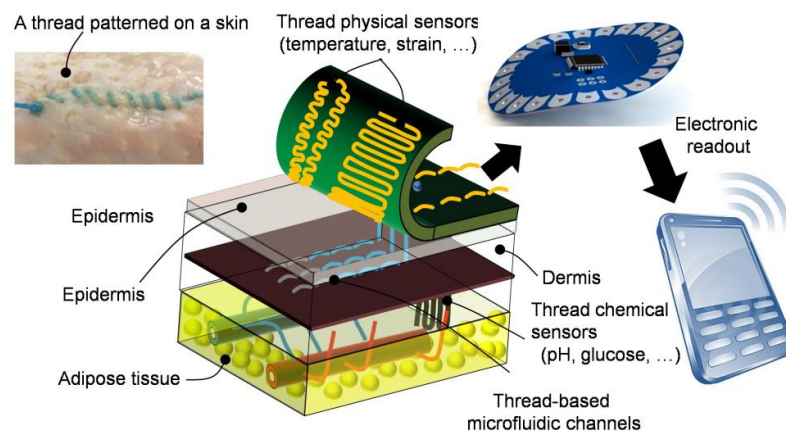


# Researchers invent 'smart' thread that collects diagnostic data when sutured into tissue

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Threads penetrate multiple layers of tissue to sample interstitial fluid and direct it to sensing threads that collect data, such as pH and glucose levels. Conductive threads then deliver the data to a flexible wireless transmitter sitting on top of the skin. The inset figure, upper left, shows liquid flowing in threads sutured into

skin. Credit: Nano Lab, Tufts University

For the first time, researchers led by Tufts University engineers have integrated nano-scale sensors, electronics and microfluidics into threads - ranging from simple cotton to sophisticated synthetics - that can be sutured through multiple layers of tissue to gather diagnostic data wirelessly in real time, according to a paper published online July 18 in *Microsystems & Nanoengineering*. The research suggests that the thread-based diagnostic platform could be an effective substrate for a new generation of implantable diagnostic devices and smart wearable systems.

The [researchers](#) used a variety of conductive threads that were dipped in physical and chemical sensing compounds and connected to wireless electronic circuitry to create a flexible platform that they sutured into tissue in rats as well as in vitro. The threads collected data on tissue health (e.g. pressure, stress, strain and temperature), pH and glucose levels that can be used to determine such things as how a wound is healing, whether infection is emerging, or whether the body's chemistry is out of balance. The results were transmitted wirelessly to a cell phone and computer.

The three-dimensional platform is able to conform to complex structures such as organs, wounds or orthopedic implants.

While more study is needed in a number of areas, including investigation of long-term biocompatibility, researchers said initial results raise the possibility of optimizing patient-specific treatments.

"The ability to suture a thread-based diagnostic device intimately in a tissue or organ environment in three dimensions adds a unique feature

that is not available with other flexible diagnostic platforms," said Sameer Sonkusale, Ph.D., corresponding author on the paper and director of the interdisciplinary Nano Lab in the Department of Electrical and Computer Engineering at Tufts University's School of Engineering. "We think thread-based devices could potentially be used as smart sutures for surgical implants, smart bandages to monitor wound healing, or integrated with textile or fabric as personalized health monitors and point-of-care diagnostics."

Until now, the structure of substrates for implantable devices has essentially been two-dimensional, limiting their usefulness to flat tissue such as skin, according to the paper. Additionally, the materials in those substrates are expensive and require specialized processing.

"By contrast, thread is abundant, inexpensive, thin and flexible, and can be easily manipulated into complex shapes," said Pooria Mostafalu, Ph.D., first author on the paper who was a doctoral student at Tufts when he worked on the project and is now a postdoctoral research fellow with the Harvard-MIT Division of Health Sciences and Technology, Brigham and Women's Hospital, and the Wyss Institute for Biologically Inspired Engineering at Harvard University. "Additionally, analytes can be delivered directly to [tissue](#) by using thread's natural wicking properties."

**More information:** Pooria Mostafalu, Mohsen Akbari, Kyle A. Alberti, Qiaobing Xu, Ali Khademhosseini, Sameer Sonkusale, "A toolkit of thread-based microfluidics, sensors, and electronics for 3D tissue embedding for medical diagnostics," *Microsystems & Nanoengineering*, online July 18, 2016, [DOI: 10.1038/micronano.2016.39](https://doi.org/10.1038/micronano.2016.39)

Provided by Tufts University

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