Sensitive nanowire disease detectors made by Yale scientists

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Yale scientists have created nanowire sensors coupled with simple microprocessor electronics that are both sensitive and specific enough to be used for point-of-care (POC) disease detection, according to a report in *Nano Letters*.

The sensors use activation of immune cells by highly specific antigens — signatures of bacteria, viruses or cancer cells — as the detector. When T cells are activated, they produce acid, and generate a tiny current in the nanowire electronics, signaling the presence of a specific antigen. The system can detect as few as 200 activated cells.

In earlier studies, these researchers demonstrated that the nanowires could detect generalized activation of this small number of T cells. The new report expands that work and shows the nanowires can identify activation from a single specific antigen even when there is substantial background "noise" from a general immune stimulation of other cells.

Describing the sensitivity of the system, senior author Tarek Fahmy, Yale assistant professor of biomedical engineering, said:. "Imagine I am the detector in a room where thousands of unrelated people are talking — and I whisper, 'Who knows me?' I am so sensitive that I can hear even a few people saying, 'I do' above the crowd noise. In the past, we could detect everyone talking — now we can hear the few above the many."

According to the authors, this level of sensitivity and specificity is unprecedented in a system that uses no dyes or radioactivity. Beyond its

sensitivity, they say, the beauty of this detection system is in its speed — producing results in seconds — and its compatibility with existing CMOS electronics.

"We simply took direction from Mother Nature and used the exquisitely sensitive and flexible detection of the immune system as the detector, and a basic physiological response of immune cells as the reporter," said postdoctoral fellow and lead author, Eric Stern. "We coupled that with existing CMOS electronics to make it easily usable."

The authors see a huge potential for the system in POC diagnostic centers in the US and in underdeveloped countries where healthcare facilities and clinics are lacking. He says it could be as simple as an iPod-like device with changeable cards to detect or diagnose disease. Importantly, Stern notes that the system produces no false positives — a necessity for POC testing.

The authors suggest that in a clinic, assays could immediately determine which strain of flu a patient has, whether or not there is an HIV infection, or what strain of tuberculosis or coli bacteria is present. Currently, there are no electronic POC diagnostic devices available for disease detection. "Instruments this sensitive could also play a role in detection of residual disease after antiviral treatments or chemotherapy," said Fahmy. "They will help with one of the greatest challenges we face in treatment of disease — knowing if we got rid of all of it."

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