technology review
Published by MIT

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Tuesday, March 1, 2011

A One-Hour Cancer Detector

A device that plugs into a smart phone lets clinicians diagnose cancer from the bedside.
By Jennifer Chu

The nerve-racking wait for cancer-screening results can go on for several days, as clinicians analyze images and biopsies. A new handheld device could significantly shorten that stressful period. Scientists at Massachusetts General Hospital and Harvard Medical School have engineered a portable device that plugs into a smart phone and reduces the time it takes to detect cancer to just an hour. The device takes a small tissue sample and quickly analyzes it for telltale cancer proteins. When the latest prototype was tested on 50 patients with gastric-related cancer, it detected malignancies with 96 percent accuracy—better than existing laboratory-based tissue-sampling tests. The results of the study were published last week in *Science Translational Medicine*.

Hakho Lee, assistant professor in the Center for Systems Biology at MGH and one of the study's authors, says the device may perform better than current methods because it reduces the possibility of human error. Typically, doctors take a biopsy from a patient and send it to the lab, where pathologists place sections of tissue on slides and analyze them under a microscope. The process is time-consuming, and suspicious proteins may go unnoticed.

"In our design, we inject everything from the patient into the device, and then it will give out a result," says Lee. Cancer cells often secrete proteins that carry out the functions of tumors, so researchers have begun looking for ways to identify protein "signatures" as early warning signs of cancer. The proteins often appear in small quantities, however, and are difficult to detect. The new device is programmed to detect key proteins expressed on a cancer cell's surface.

Lee and his colleagues made innovative use of nanotechnology in order to detect multiple types of cancer proteins simultaneously, from a minuscule tissue sample. The group designed a microchip that houses a solution containing magnetic nanoparticles. They identified 11 proteins commonly expressed by gastric-related cancers and attached a corresponding ligand or binding molecule, to each nanoparticle. Then they obtained tissue samples from 50 patients and injected the samples into the microchip. The device creates a magnetic field and uses it to determine which proteins had locked onto the nanoparticles. The device needs to detect only four out of the 11 proteins to achieve its 96 percent rate of accuracy, in a process that takes just about an hour.

Lee says the study also produced an important new finding: after an hour, the proteins started to degrade quickly, and the group had greater difficulty in detecting them than it did with fresh samples. "This tells us we have to either fix the sample to fix the proteins on the cell surface, or there should be a method that can be portable and in the clinic so that doctors can get samples and do the measurement on the spot," says Lee. Toward that end, Lee's group has designed the microchip to plug into a smart phone, which, armed with software, can analyze protein levels and quickly deliver a diagnosis at the patient's bedside.

James Heath, professor of chemistry at California Institute of Technology, says the device is a sensitive and user-friendly way of diagnosing cancer, and may also provide researchers with a fast and accurate way to detect other proteins of interest.

"People would like to do protein-based diagnostics via blood analysis," says Heath. "For either blood or tissue analysis, sample degradation over time is a common issue. [This device] certainly overcomes the challenge ... since the measurements are all done very quickly following biopsy."

Lee's group is currently adapting the device to detect proteins associated with tuberculosis and will soon begin clinical trials to test another prototype for ovarian cancer.