Lab on a chip for cheap, portable medical tests

January 29 2008

University of Alberta researchers in Edmonton, Canada, have developed a portable unit for genetic testing about the size of a shoebox, which has the same capability as a lab full of expensive equipment.

The device – along with other, even smaller units the team is now in the process of developing – paves the way for enormous savings to health-care systems and will improve care for patients. A wide variety of genetic tests that are available but not often used because their cost is prohibitive will become cheap, fast and easily accessible.

Prof. Christopher Backhouse, of the Department of Electrical and Computer Engineering, together with Dr. Linda Pilarski, an oncology professor in the Faculty of Medicine and Dentistry, and their research team, have received international recognition for the device. An article describing their “shoebox-sized” portable unit appears in the Jan. 18, 2008, issue of The Analyst, a scientific journal published by the Royal Society of Chemistry based in the United Kingdom. The article lead author is University of Alberta PhD student Govind V. Kaigala.

A royal society publication (Chemical Science) heralded the device in an online article featuring the advance, and indicated the University of Alberta is winning the global race to use micro and nano-biotechnology in developing diagnostic applications for so-called lab-on-chip technology.

It said:

“Canadian scientists have succeeded in building the least expensive portable device for rapid genetic testing ever made. The cost of carrying out a single genetic test currently varies from hundreds to thousands of pounds, and the wait for results can take weeks. Now a group led by Christopher Backhouse, University of Alberta, Edmonton, have developed a reusable microchip-based system that costs just 500 (pounds) to build, is small enough to be portable, and can be used for point-of-care medical testing.”

Backhouse compares the development of these technologies to the development of computers:

“In the early days of computers, they were inaccessible - million-dollar beasts that filled a room and you needed a PhD to be able to operate one. Nowadays, everybody has one and they’re even in kindergarten classes,” he says.

He says miniaturization made that possible and brought the cost factor down by about a million.

“In health care we need that even more. Life science technologies exist but they are not being utilized because they are very expensive,” Backhouse adds. “We’ve applied the same miniaturization technologies to health care that were applied to computers by coming up with portable, lab-on-a-chip technologies that are easy to use.”

The engineering team has been building and testing the units in the University of Alberta’s Micro and Nano Fabrication Facility (commonly called the NanoFab), an open-access lab used by U of A researchers, and scientists from other universities and high-tech companies.

“We can work on a drop of almost anything,” Backhouse says of their diagnostic unit. It takes about an hour to get the results.

The heart of the unit, the ‘chip,’ looks like a standard microscope slide etched with fine silver and gold lines. That microfabricated chip applies nano-biotechnologies within tiny volumes, sometimes working with only a few molecules of sample. Because of this highly integrated chip (containing microfluidics and microscale devices), the remainder of the system is inexpensive ($1,000) and fast.

There are many possible uses for such a portable genetic testing unit:

Backhouse notes that adverse drug reactions are a major problem in health care. By running a quick genetic test on a cancer patient, for example, doctors might pinpoint the type of cancer and determine the best drug and correct dosage for the individual.

Or health-care professionals can easily look for the genetic signature for a virus or E. coli – also making it useful for testing water quality.

“From a public health point of view, it would be wonderful during an epidemic to be able to do a quick test on a patient when they walk into an emergency room and be able to say, ‘you have SARS, you need to go into that (isolation) room immediately.’ ”

A family doctor might determine a person’s genetic predisposition to an illness during an office visit and advise the patient on preventative lifestyle changes.

The work that led to the existing $1,000 system is part of a larger engineering collaboration in which electrical engineers Drs. Chris Backhouse, Duncan Elliot and Jim McMullin from the U of A, along with Dr. Paul Charette at the Universite de Sherbrooke (Quebec), are combining skills to put much of the functionality of a medical diagnostic lab on a far smaller instrument. This requires a combination of photonics, nano-biotechnology, electronics, microfabrication and

programming.

Since the journal article was submitted to the Royal Society of Chemistry, the U of A researchers have already made the processor and unit smaller and have brought the cost of building it down to about $100 Cdn. In addition, these systems are also portable and even faster (they take only minutes).

Backhouse, Elliott and McMullin are now demonstrating prototypes of a USB key-like system that may ultimately be as inexpensive as standard USB memory keys that are in common use – only tens of dollars.

“You (would) put on your sample, plug it into a computer and have the answer in 15 minutes.”

Along with other researchers at the U of A and in local health-care agencies, these researchers are applying their instruments to a wide range of applications, from public health to cancer treatment, while working with Canada's industry leaders in the field, with partners such as DALSA, Micralyne and iLOC.

Source: University of Alberta