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Next-Generation Microfluidic Point-of-Care Diagnostics

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Dr Alphonsus Ng.
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Guest:
Dr. Alphonsus Ng is a postdoctoral fellow at the Institute of Biomaterials and Biomedical Engineering at the University of Toronto.

Bob Barrett: This is a podcast from *Clinical Chemistry*, sponsored by the Department of Laboratory Medicine at Boston Children's Hospital. I am Bob Barrett.

Microfluidics or Lab-on-a-Chip diagnostic devices have the potential to provide fast laboratory quality results at the point of need to expedite clinical decisions. Unfortunately, many of these technologies remain out of the reach in resource-limited situations, where a lack of access to quality diagnosis contributes to the burden of disease.

A prospective article in the September 2015 issue of *Clinical Chemistry* examines the current progress of developing quality diagnostic tests using smartphone technology and thoughtful system integration, for faster and cheaper testing without compromising the quality of the analysis.

The lead author of that article is Dr. Alphonsus Ng from the Institute of Biomaterials & Biomedical Engineering at the University of Toronto. He joins us in this podcast.

Dr. Ng, what exactly is Microfluidics and how can it help with point-of-care diagnostics?

Dr. Alphonsus Ng: Microfluidics is the science of miniaturizing fluid handling in microfabricated features with micron-linked dimensions. And the idea is that fluids can be precisely manipulated using a microscale device that is built with the same technologies used in the semiconductor industry to miniaturize electronics.

Microfluidics has attracted a lot of attention across a wide range of disciplines because of the potential for using it to analyze tiny samples and to integrate processes onto handheld Labs-on-a-Chip.

So instead of sending vials of blood to a central laboratory and getting results back days later, you can imagine a Microfluidic device that can give you the same performance,

but with a finger prick of blood right on the spot, in minutes. This will be useful in the US and Canada, because in the doctor's office if they want to get a blood test from you, you can do the test right then and have the conversation about your results on the same visit; and, in the developing world it becomes critical, because some of the patients don't even have access to these tests.

Bob Barrett: How is this different from off-the-shelf tests we see now, like for pregnancy or HIV?

Dr. Alphonsus Ng: Off-the-shelf tests for pregnancy or HIV are a class for paper-based devices called Lateral Flow Tests. It relies on waking of water through the paper to drive fluids in one direction.

It is very simple and inexpensive, but the fluid handling is so simple that it is not able to replicate the same type of performance that you would get in the laboratory.

For example, in one study published in *Clinical Chemistry*, which features a head-to-head comparison of HIV lateral flow tests with the gold standard, it reveals that lateral flow tests can sometimes give the wrong results when you have a weak-positive specimen, and I think a part of the problem is the need to interpret the results. So after you perform the test, you have to visually inspect your test strip for the presence of a colored band, which is prone to error.

It depends on who is looking at it and the lighting conditions at that time. But many researchers are working on improving the performance of the lateral flow tests by making designs that are two-dimensional or three-dimensional and using a reader to interpret the test band.

Bob Barrett: You mentioned developing countries and Microfluidics technology seems well-suited for the developing world, with limited access to centralized testing. Are these devices out in the field yet?

Dr. Alphonsus Ng: Although Microfluidics technology is starting to make a difference in countries like the US and Canada, these technologies remain mostly out of reach in the developing world. But I think this will change very soon with the help of the consumer electronics industry, and in particular with the help of smartphones.

In the prospective article we highlighted a paper recently published in Science Translational Medicine by Professor Samuel Sia and colleagues at Columbia University in New York. And using Microfluidics technology they developed a dongle that plugs directly into your smartphone, which can

be used to test for HIV and syphilis simultaneously, with an answer back in just 15 minutes.

These smartphone dongles were first sent to Rwanda, where healthcare workers tested 96 patients. The test performed just as well as the gold standard tests, but because it only required a finger prick rather than drawing blood, nearly all of the patients preferred it.

The manufacturing cost of the dongle was just $34 and the material cost for each multiplex test is about $1.50. One of the reasons why the dongle is relatively inexpensive is because it is outsourcing a lot of functions to the smartphone. Things like data handling, user interface, telecommunications, and power are already available inside a smartphone.

So by leveraging the advances of smartphone technology and their penetration in the developing world, I think Microfluidics diagnostic devices will start to make a difference very soon in resource-limited settings.

Bob Barrett: Well, finally Dr. Ng, let's look ahead, can you tell us what you think the future of diagnostics will look like?

Dr. Alphonsus Ng: I think the future of diagnostics is really bright, for both the developed world and the developing world.

In the developed world consumer adoption of health monitoring devices is increasing rapidly, and I think Microfluidics devices can empower consumers to monitor their health at the pharmacy or at home and reduce the burden of healthcare system.

As the demand of these devices increase, consumer electronic companies will begin to dedicate more money and resources for the developments of these devices. Eventually their adoption in the developing world will also increase, just like the smartphone. This will allow us to conduct the surveillance through the cloud, which can help prevent outbreaks of disease, and allow healthcare workers to quickly identify and treat diseased individuals. This will ultimately help lower the burden of disease across the world.

Bob Barrett: Dr. Alphonsus Ng is a postdoctoral fellow at the Institute of Biomaterials & Biomedical Engineering at the University of Toronto. He has been our guest in this podcast from *Clinical Chemistry* on Microfluidics and smartphone-based diagnostics.

I am Bob Barrett. Thanks for listening.