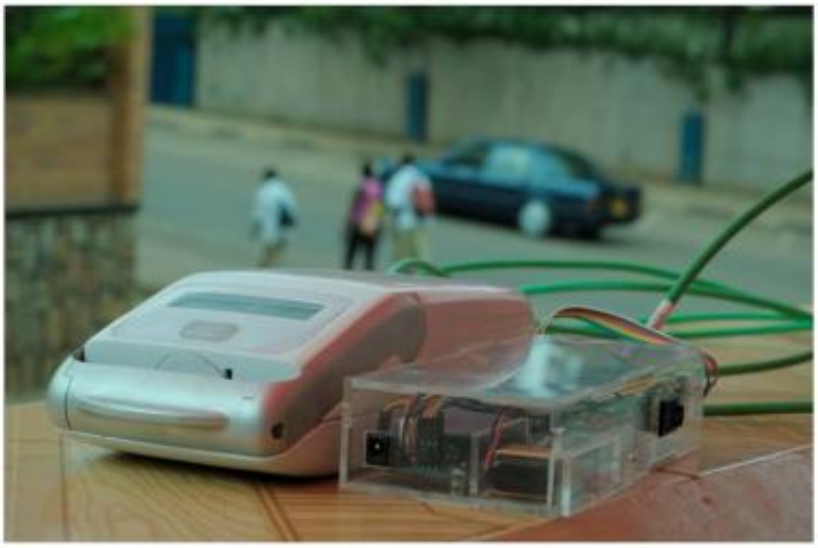
Fast, low-cost device uses the cloud to speed up diagnostic testing for HIV, more

January 24 2013



Columbia engineering professor Sam Sia's handheld mobile device is a fast, low-cost device that uses the cloud to speed up diagnostic testing for HIV and more -- the mChip can easily be used in remote areas around the world. The mChip mobile device is on the left, with a satellite communication modem on the right. Credit: Columbia Engineering

Samuel K. Sia, associate professor of biomedical engineering at

Columbia Engineering, has taken his innovative lab-on-a-chip and developed a way to not only check a patient's HIV status anywhere in the world with just a finger prick, but also synchronize the results automatically and instantaneously with central health-care records—10 times faster, the researchers say, than the benchtop ELISA, a broadly used diagnostic technique. The device was field-tested in Rwanda by a collaborative team from the Sia lab and ICAP at Columbia's Mailman School of Public Health.

In the study published online January 18, 2013, in Clinical Chemistry, and in the print April 2013 issue, Sia describes a major advance towards providing people in remote areas of the world with laboratory-quality diagnostic services traditionally available only in centralized health care settings.

"We've built a handheld mobile device that can perform laboratory-quality HIV testing, and do it in just 15 minutes and on finger-pricked whole blood," Sia says. "And, unlike current HIV rapid tests, our device can pick up positive samples normally missed by lateral flow tests, and automatically synchronize the test results with patient health records across the globe using both the cell phone and satellite networks."

Sia collaborated with Claros Diagnostics (a company he co-founded, now called OPKO Diagnostics) to develop a pioneering strategy for an integrated microfluidic-based diagnostic device—the mChip—that can perform complex laboratory assays, and do so with such simplicity that these tests can easily be carried out anywhere, including in resource-limited settings, at a very low cost. This new study builds upon his earlier scientific concepts and incorporates a number of new engineering elements that make the test automated to run with data communication over both cell phone and satellite networks.

"There are a set of core functions that such a mobile device has to

deliver," he says. "These include fluid pumping, optical detection, and real-time synchronization of diagnostic results with patient records in the cloud. We've been able to engineer all these functions on a handheld mobile device and all powered by a battery."

This new technology, which combines cell phone and satellite communication technologies with fluid miniaturization techniques for performing all essential ELISA functions, could lead to diagnosis and treatment for HIV-infected people who, because they cannot get to centralized health care centers, do not get tested or treated.

"This is an important step forward for us towards making a real impact on patients," says Jessica Justman, MD, senior technical director at ICAP and associate clinical professor of medicine in epidemiology at the Mailman School of Public Health. "And with the real-time data upload, policymakers and epidemiologists can also monitor disease prevalence across geographical regions more quickly and effectively."

Working with ICAP, OPKO, the Rwandan Ministry of Health, and Rwandan collaborators at Muhima Hospital and two health clinics—Projet San Francisco and Projet Ubuzima, Sia and his team assessed the device's ability to perform HIV testing and then synchronized results in real time with the patients' electronic health records. They successfully tested over 200 serum, plasma, and whole blood samples, all collected in Rwanda.

The mobile device also successfully transmitted all whole-blood test results from a Rwandan clinic to a medical records database stored on the cloud. The device produced results in agreement with a leading ELISA test, including detection of weakly positive samples that were missed by existing rapid tests. The device operated autonomously with minimal user input, produced each result in 15 minutes (compared to 3 hours with the benchtop ELISA), and consumed as little power as a

mobile phone.

This latest study builds on previous work from the Sia Lab on building a lab-on-a-chip for personal health diagnosis. For this earlier device, Columbia University was named a Medical Devices runner-up in The Wall Street Journal's prestigious Technology Innovation Awards in 2011.

This research has been funded by a $2-million Saving Lives at Birth transition grant (United States Agency for International Development, the Bill & Melinda Gates Foundation, Government of Norway, Grand Challenges Canada, and the World Bank).

Sia's next step will be to implement an antenatal care panel for diagnosing HIV and sexually transmitted diseases for pregnant women in Rwanda. He is also exploring the use of this technology for improving personal health for consumers in the United States.

"The ability to perform state-of-the-art diagnostics on mobile devices has the potential to revolutionize how patients manage their health," Sia says. "I'm pleased with the progress we have made so far, and we are working hard with our collaborators to bring this technology to clinicians, patients, and consumers."

Provided by Columbia University

Citation: Fast, low-cost device uses the cloud to speed up diagnostic testing for HIV, more (2013, January 24) retrieved 24 April 2024 from https://phys.org/news/2013-01-fast-low-cost-device-cloud-diagnostic.html

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