Portable 'paper machine' can diagnose disease for less than $2

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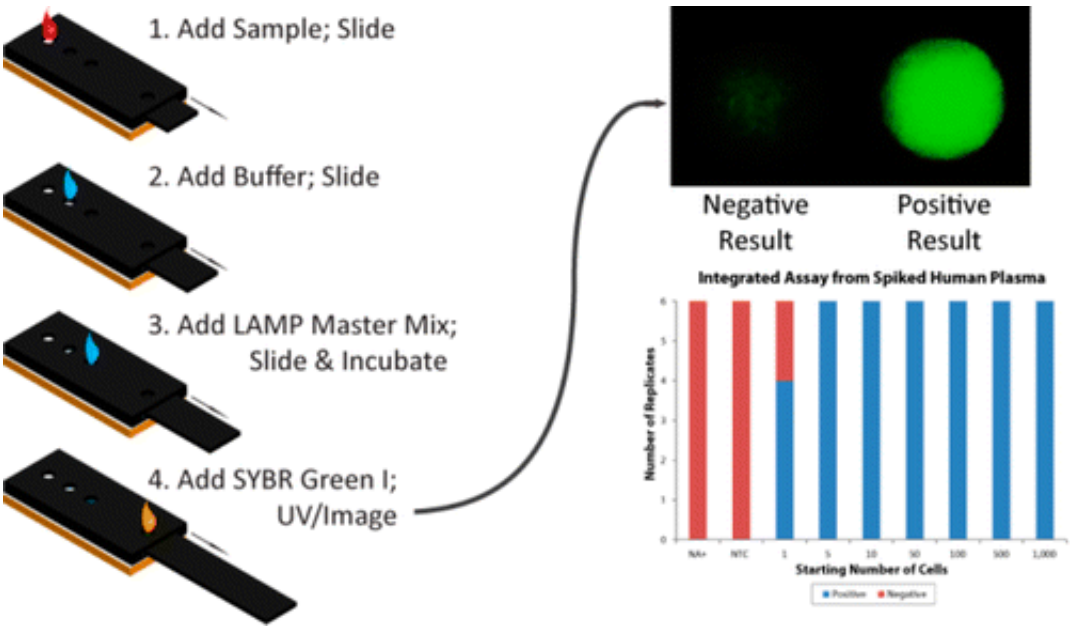

In the U.S. and other industrialized nations, testing for infectious diseases and cancer often requires expensive equipment and highly trained specialists. In countries where resources are limited, performing the same diagnostics is far more challenging. To address this disparity, scientists are developing a portable, low-cost "paper machine" for point-of-care detection of infectious diseases, genetic conditions and cancer. Their report appears in the ACS journal *Analytical Chemistry*.

Many modern diagnostic techniques involve analyzing DNA in a patient's blood sample. If pathogenic bacteria, for example, are present, the test will detect the foreign genetic material. Part of the barrier to bringing this kind of technology everywhere is that it often requires multiple steps under precisely controlled temperatures to prepare a sample and analyze it. Scientists are working to simplify these procedures, but most are still not ideal for remote locations. John T. Connelly and colleagues set out to make this critical technology more accessible.

Using materials that cost a less than $2 total, the researchers condensed sample preparation, DNA analysis and detection steps into a hand-held paper machine. It successfully determined whether as few as five cells of E. coli were present in test samples.

The results can be read using ultraviolet light and a smartphone camera. The researchers say they are further refining the machine to make it even simpler to use.

More information: A 'Paper Machine' for Molecular Diagnostics, *Anal. Chem.*, Article ASAP. DOI: 10.1021/acs.analchem.5b00411

Abstract
Clinical tests based on primer-initiated amplification of specific nucleic acid sequences achieve high levels of sensitivity and specificity. Despite these desirable characteristics, these tests have not reached their full potential because their complexity and expense limit their usefulness to centralized laboratories. This paper describes a device that integrates sample preparation and loop-mediated isothermal amplification (LAMP) with end point detection using a hand-held UV source and camera phone. The prototype device integrates paper microfluidics (to enable fluid handling) and a multilayer structure, or a "paper machine", that allows a central patterned paper strip to slide in and out of fluidic path

and thus allows introduction of sample, wash buffers, amplification master mix, and detection reagents with minimal pipetting, in a hand-held, disposable device intended for point-of-care use in resource-limited environments. This device creates a dynamic seal that prevents evaporation during incubation at 65 °C for 1 h. This interval is sufficient to allow a LAMP reaction for the Escherichia coli malB gene to proceed with an analytical sensitivity of 1 double-stranded DNA target copy. Starting with human plasma spiked with whole, live E. coli cells, this paper demonstrates full integration of sample preparation with LAMP amplification and end point detection with a limit of detection of 5 cells. Further, it shows that the method used to prepare sample enables concentration of DNA from sample volumes commonly available from fingerstick blood draw.

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