

LOCALIZING CHEMICAL AND BIOLOGICAL THREAT DETECTION

Development And Validation Of A Portable Device For Lab-free Universal Nucleic Acid Extraction

Anthony Politza The Pennsylvania State University **Tianyi Liu** The Pennsylvania State University **Aneesh Kshirsagar** The Pennsylvania State University **Weihua Guan** The Pennsylvania State University

Nucleic acid testing (NAT) has revolutionized diagnostics by providing precise, rapid, and scalable detection methods for diverse biological samples. There is an increasing demand for on-site diagnostics, suitable for low-resource applications. Despite these technological advancements, sample preparation remains a significant challenge that undermines the sensitivity of diagnostic assays. This presents a crucial gap in the effective deployment of NAT technologies, particularly in field testing, where resources are limited. One common format for POC-NAT devices is the combination of sample preparation and diagnostic assays in a single microfluidic cartridge. This format of device is highly needed for applications that require sample-in-answer-out but requires redesigning the cartridge for each new application. It is well known that the sensitivity of these integrated systems frequently falls short of traditional laboratory methods, therefore demonstrating the need for a general-purpose sample preparation device. To address this, we developed a portable, lab-free, and battery-powered device for extracting nucleic acids. This device is fully compatible with existing commercial chemistries and materials, making it versatile for different sample types. We found that the portable device could provide sufficient centrifugal force for successful extractions. The battery-powered device could perform at least 30 extractions in the field. We demonstrated the ability of the device to withstand room temperature storage out to 6 months with no loss in performance. Extraction performance was rigorously tested by comparing the device's results with those from a conventional laboratory centrifuge across three types of samples: HIV RNA in buffer, HIV RNA in plasma, and SARS-CoV-2 RNA in saliva. The portable device demonstrated excellent agreement with the benchtop centrifuge, indicating high reliability and performance. By providing an effective on-site sample preparation solution, this device would greatly improve the sensitivity and reliability of field diagnostic tests. Compatibility with commercial chemistries broadens the impact of our device for field deployable versions of NAT, next generation sequencing (NGS), biomarker detection, or environmental monitoring.

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