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ORIGINAL ARTICLE

Filtration Analysis of Microparticles Using Paper-Based Microfluidics

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Abstract

A virus is a sub-microscopic infectious organism that causes diseases in humans, animals, and plants resulting in morbidity and may cause mortality. Proper diagnosis is necessary to initiate the treatment and pave the way to eradicate the viral infection. The current diagnostic kits for nucleic acid amplification assay, blood filtration, single-cell analysis are highly accurate, even though the procedure necessitates large sample volumes, complicated fabrication steps, time-consuming processes, and high costs. The filtration of viral samples from the blood is a tedious process. In this research, we have presented a home-based fabricated paper microfluidic chip to effectively filtrate viral particles from the sample to facilitate the nucleic acid amplification assay. The filtration analysis was exhibited for lateral and vertical flow paper chips fabricated via laser printing and polyethylene terephthalate (PET) encapsulation that circumvents the necessity of a traditional wax printer and hot plate. The results convey that the vertical flow paper chip with grade 4 inlet and outlet filters 98.57% of unnecessary particles from the sample. The paper-based microfluidic chip developed in this research is simple, easy to fabricate, and inexpensive to access in underdeveloped countries. The paper chip can pave the way for applications like lab-on-chip devices, POC assays, rapid nucleic acid amplification tests, cell cultures, and biomolecular research.

Keywords Microfluidic chip · Point-of-care chip · Lab-on-chip · Paper chip · Particle filtration

Introduction

Paper-based viral filtration is a low-cost and simple technique that has the potential to be used for the detection and removal of viruses from various samples, including blood [1]. Bloodborne viruses, such as hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), are major global health concerns, and early detection and treatment of these viruses are critical for reducing the risk of transmission and improving patient outcomes [2]. However, existing methods for virus detection and removal from blood samples are often expensive, time-consuming, and require specialized equipment, which can limit their use in resource-limited settings. Paper-based viral filtration methods offer a promising alternative to these existing methods [3]. The virus is an infectious organism with some genetic code wrapped by a protein coat with a size ranging from 20 to 400 nm diameter that incorporates into body cells and is programmed to increase rapidly [4, 5]. The viral infection leads to morbidity and can cause mortality. Despite enormous efforts and recent major advancements in public healthcare, reducing contagious disease mortality is a difficult and vital challenge. Several viruses enhanced the risk of worldwide outbreaks leading to massive social and economic burdens on affected countries. The worldwide threat of viral illness epidemics highlights the need for rapid, accurate, and sensitive detection approaches and diagnostic kits to accelerate the diagnosis and enable early intervention [3, 6]. The separation of plasma or removal of blood

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