B36 Colorimetric-Based Paper Microfluidic Devices for the Presumptive Determination of Seized Drugs

Ling Wang, MS, Florida International University, CP-304 11200 SW 8th Street, Miami, FL 33199; Bruce R. McCord, PhD, Florida International University, Dept of Chemistry, University Park, Miami, FL 33199; Giacomo Musile, PhD, Università Di Verona, p.le Scuro 10, Dept Legal Medicine, Verona 37134, ITALY; Jashaun Bottoms, Tuskegee University, 1200 W Montgomery Road, Tuskegee, AL 36088; and Franco Tagliaro, PhD, MD, Dept of Medicine & Public Health, Policlinico GB Rossi, P. le Scuro No. 10, Verona 37134, ITALY*

The goal of this presentation is to describe the development of colorimetric-based paper microfluidic devices for the presumptive determination of seized drugs. Information provided will include the optimized design of a multi-channel paper microfluidic device, the multiplexed detection of different controlled substances, and the development validation of the multi-channel paper chip.

This presentation will impact the forensic science community by demonstrating the application of this newly designed paper microfluidic device in the presumptive detection of seized drugs. The new method is rapid, inexpensive, and applicable to a wide variety of seized drugs.

Colorimetric reagents have been used for testing seized drugs for many years. Although these reagents provide a useful presumptive determination, they are less convenient and more dangerous because of the presence of toxic and corrosive chemicals. This research provides an alternative platform for colorimetric detection based on paper microfluidics. To this end, six-channel chips were created that adapt these colorimetric reagents to a multiplexed ready-to-use format. Each lane performs a different test. In the field, samples are dissolved in a carrier solvent in vials, then applied to the paper just prior to analysis. These devices can be used at crime scenes, laboratories, and any other locations where seized drugs need detection. These paper microfluidic devices are easy to prepare, inexpensive to operate, and can be conveniently stored for later use with shelf lives of two to three months.

The paper microfluidic devices are designed as a six-channel multiplexed system. Preparation of the devices requires a wax-ink printer, thermal laminator, chromatography paper, and colorimetric reagents. The wax-ink printer and a thermal laminator produce hydrophilic channels defined by melted wax on the paper. Next, a variety of different colorimetric reagents are prepared and a different test is prepared for each channel to create six simultaneous and separate detection zones. Drugs in powder form are dissolved in solutions then transferred to the chips where they move to the detection zone via capillary action. Sequences of different reagents can be applied to each channel to produce a series of reactions and the color changes appear at the end of each channel. The entire process takes less than five minutes. Because each specific drug can produce a color change that depends on the specific reagent in each channel, it becomes possible to presumptively determine the type of drug in the test solution.

One important aspect of this study is the selection of potential reagents for the device. Traditional colorimetric reagents, such as the Mandelin and Froehde reagents, use concentrated sulfuric acids. Acids such as sulfuric acid and nitric acid can burn and digest chromatographic paper. As a result, a variety of chemical tests were performed to modify these reagents in order to make them more compatible with the paper-based format. For example, potassium manganate (VII), copper (II) sulfate, and iron (III) have been utilized in various forms to create alternate colorimetric reagents. The adjusted reagents produce specific color changes for seized drugs on the paper microfluidic devices. Procedures have been developed for the detection of cocaine, ketamine, codeine, ephedrine, morphine, amphetamine, methamphetamine, and MDMA. These devices have been tested for sensitivity, specificity, and stability against a variety of potential interferences and test conditions.

The use of paper microfluidic devices permits the development of rapid, inexpensive, and easily operated tests for a variety of seized drugs. They present a safe and convenient presumptive tool for samples that can be used in the field, prior to confirmatory laboratory analysis.

Paper Microfluidic Devices, Colorimetric Reagents, Seized Drugs

*Presenting Author