B24 The Development of Paper Microfluidic Devices for the Presumptive Determination of Seized Drugs

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The goal of this presentation is to demonstrate the application of paper microfluidic devices and colorimetric tests in the presumptive determination of seized drugs. Information will be presented on the design of paper-based multiplexed colorimetric detection, how to optimize detection of drugs on paper microfluidic devices, and will demonstrate a variety of applications of the multichannel paper chips.

This presentation will impact the forensic science community by demonstrating the application of paper microfluidic devices as a useful tool for detecting seized drugs in solution. The new method is rapid, inexpensive, and applicable to a variety of seized drugs.

Currently, a wide variety of illicit drugs can be screened using presumptive colorimetric test solutions. These colorimetric reagents have been used to detect seized drugs for many years; however, the storage of these solutions not only occupies space but also involves the use of toxic and corrosive chemicals. Use of these tests in the field can be awkward and may not always be possible in challenging environments. This study has been working on an alternative platform for colorimetric detection based on paper microfluidic devices. Using wax printing and chromatographic paper, four lane chips have been created that adapt the colorimetric reagents to a ready-to-use format. Sample and solvent are applied to the paper just prior to analysis and each lane performs a different test. These devices can be used at crime scenes, in laboratories, and at any other location where seized drugs need identification. The preparation of paper microfluidic devices is simple and inexpensive and they can be conveniently stored for later use.

The paper microfluidic devices are designed as a four-channel multiplexed system. Preparation of the devices requires a wax-ink printer, chromatography paper, and colorimetric reagents. A series of hydrophilic channels are created and outlined in wax on the paper using the wax-ink printer and a laminator. Next, a set of different colorimetric reagents are spotted in each channel to create the detection zone. Drugs dissolved in solutions are 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 finally appear at the end of each channel. The entire process generally takes less than five minutes. Because each drug can produce specific color changes in different channels, it becomes possible to presumptively determine the type of drugs in solutions.

One important aspect of this project is the selection of potential reagents for the device. Traditional colorimetric reagents, such as the Mandeline and Frohdes 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 have been performed to modify these reagents to make them more compatible with the paper-based format. For example, potassium manganate (VII), copper (II) sulfate, and iron (III) oxide have been utilized as alternative reagents. The adjusted colorimetric reagents produce specific color changes for seized drugs on paper microfluidic devices. Procedures have been developed for the detection of cocaine, ketamine, codeine, and ephedrine and have been tested against a variety of potential interferences.

Overall, the use of paper microfluidic devices permits the development of rapid, easily stored test beds for a variety of seized drugs. They present a quick presumptive tool for samples which can be used in the field, prior to confirmatory laboratory analysis.

Paper Microfluidic Devices, Seized Drugs, Colorimetric Test