Paper Based Microfluidic Device for Point of Care Drug Differentiation

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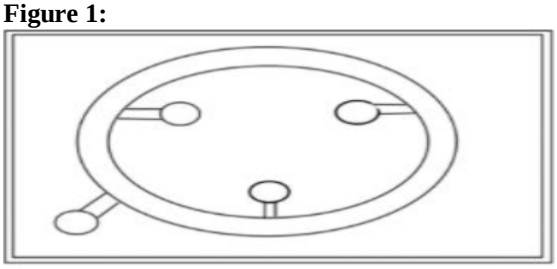
Purpose: The purpose of this design project is to create a cheap, fast acting and effective device to be used in point of care treatment of overdose victims for rapid drug overdose differentiation. According to the National Institute of Drug Abuse, the United states so over 70,000 drug overdose deaths in 2017[3]. Three different types of narcotics; opioids, benzodiazepines and barbiturates., produce similar symptoms when reaching a toxic level including (but not limited to) confusion, loss of consciousness, slow or labored breathing and muscle weakness or limpness[4]. From several contacts, it was determined that in many cases, a first responder to an overdose situation scene will often immediately administer naloxone, a chemical that binds to opioid receptors and effective counteracts the effects of opioids on the body. This treatment has no effect in the case of a barbiturate or benzodiazepine overdose but has no other adverse side effects. Often, Flumenazil, a treatment used to counteract the effects of benzodiazepines is then administered but can cause serious health hazards including increasing the risk of seizures and shock in the patient[4]. Both treatments are costly are not effective in all scenarios.

Theories/Methods: This device was designed in order to meet the need for a drug differentiation that will save time and money in the case of point of care treatment of drug overdoses The device involves wax printed lines on chromatography paper that, when melted, create a hydrophobic boundary layer[5]. The idea is to create hydrophilic channel inside of the hydrophobic boundary that can subsequently control direction and maximize fluid movement throughout the paper. Inside of the device, a chromophore will be implanted that will change color upon the introduction of the target narcotic to show a positive or negative reading of the sample[3]. Furthermore, the device will have several locations in which different, narcotic specific chromophores will be planted to allow for presence readings of several narcotics at once as well as differentiation between the narcotics as depicted in **Figure 1.**

Figure 1:



Results: For proof of concept, a device was developed which uses these principles to detect the presence of alcohol in the blood. **Figure 1** show the progression of differing prototype designs for a singular channel device. **Table 1** shows the average differential transmittance in response to alcohol between a control sample and a chromophore implanted sample. The table shows a series of samples with different chromophore concentrations.

Figure 2:

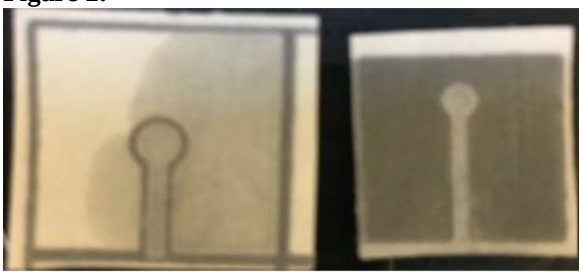


Table 1:

%Difference of Average %Transmittance Between Sample Groups					
Wavelength /sample	420	440	460	480	500
B 0.5M old	163.61	161.58	64.52	97.91	47.34
C 0.017M old	81.96	77.34	29.76	38.52	18.06
D 0.5 M new	176.72	173.91	101.30	112.61	56.04
E 0.017M new	128.52	120.83	61.38	64.30	29.17

Conclusion: The hydrophobic boundary layer has proven to be a viable concept for fluid transport and wax printing has proven to be a cheap and effect way of manufacturing devices using this concept. The next steps for the project is to determine the optimal process for implanting the chromophore into the chromatography paper and to begin using blood plasma for prototype testing.

References:

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