Early Detection of Malaria Infection with Portable and Electricity Free Isothermal Loop Amplification (LAMP)

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BACKGROUND: Malaria is a disease that mainly affects the poor, and is caused by a parasite (plasmodium) that cannot reproduce outside of humans. Most malaria patients are asymptomatic until late stages. No methods exist to detect low levels of plasmodium in humans without expensive lab equipment. A huge need exists to detect malaria infection in early stages so that transmission can be contained. Isothermal loop amplification (LAMP) is a new portable technology that inexpensively detects small quantities of DNA. METHODS: A four part system to detect malaria DNA using LAMP was created: 1) Heating container 2) Flameless heater 3) Microfluidic chip and 4) Smartphone app. Off-the-shelf camping equipment and meals ready to eat (MRE) heating packs were used. Beeswax was used as a phase change material along with a heatsink to deliver heat directly to the microfluidic chip. Additional parts were 3D printed using heat resistant filament. A tri-layer microfluidic chip was engraved using a CO2 laser and contains silica membranes to bind DNA. Crystal violet was used to measure DNA amplification. Color intensity was measured using a smartphone app. RESULTS: 60 microfluidic LAMPs were run to amplify plasmodium aldolase and histidine rich protein-2. Correlation between DNA concentration and color intensity was high ($r2 = 0.91$, $p < 0.001$). CONCLUSION: Current methods to detect malaria only work in late stages of the disease. Microfluidic LAMP is portable, electricity-free, easy to use and cheap ($5 per sample). Microfluidic LAMP may be useful in the developing world to help eradicate malaria.

Awards Won:

Third Award of $1,000

University of the Sciences in Philadelphia: Tuition Scholarship of $15,000 per year for four years.