Point of Care Testing for Malaria Using a Smartphone and a Microfluidic ELISA System

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Drug resistant malarial parasites and inability to monitor patient response to treatment kill nearly a million people every year. Enzyme linked immunosorbent assay (ELISA) is a highly sensitive way to detect malaria, but is time consuming, requires electricity and costly equipment like a spectrophotometer. I developed a system to measure malaria proteins (plasmodium aldolase) that can be used in resource constrained settings. The system is made up of: 1) microfluidic ELISA disk 2) hand crank centrifuge 3) photographic box and 4) smartphone app. A dual layer circular microfluidic disk was created using 3 mm optically clear acrylic and a CO2 laser. Lamination was performed with 3M 501FL adhesive. A series of capillary valves were incorporated to release reagents at precise times based upon centrifugal force. Color change was measured with a smartphone camera. The disk was compared to a 96 well sandwich ELISA. The ELISA contained: primary antibody: mouse anti-plasmodium aldolase and secondary/conjugate antibody: rabbit anti-plasmodium aldolase-horseradish peroxidase. Results from standard ELISA were compared to ELISA disk. Over 30 different microfluidic patterns were tested. The final prototype disk was compared to standard sandwich ELISA (n=20) using samples of aldolase (0.1 to 10 ng/mL). Color readings of standard ELISA and microfluidic disk showed similar results except for very low concentrations (<0.1 ng/mL). The microfluidic system performed just as well as the standard ELISA except at very low concentrations. The cost of the microfluidic system is approximately $10 per sample compared to over $1000 per sample for a standard ELISA. This system works without electricity, could improve access to monitoring in rural areas and help identify resistant strains quickly.

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