NON-INVASIVE, EARLY WARNING & SURVEILLANCE TOOL FOR MALARIA AND ARBOVIRUSES

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Introduction: Vector-borne diseases are a rising global health concern, with pathogens likely to spread to new areas, or reemerge, largely due to climate change. In recent decades, efforts to reduce these diseases, including the implementation of innovative surveillance interventions, has reportedly stalled. This stagnation is mainly due to the challenge of detecting undiagnosed asymptomatic carriers of malaria and arboviruses, which can account for up to 60% of cases. As well, routine surveillance rarely includes the detection of infected mosquitoes, causing delays in vector control responses. Addressing future outbreaks and pandemics requires a global effort, with scalable surveillance systems providing routine data, early warnings, rapid responses, and coordinated disease control. Current pathogen detection methods are time-consuming, laboratory-bound, costly for large-scale use and less effective for asymptomatic cases.

Objective: Evaluate whether near-infrared spectroscopy (NIRS) is capable of rapidly and non-invasively detecting pathogens in humans and mosquitoes.

Methods: To evaluate the NIRS technique, we collected spectra from *Aedes aegypti* mosquitoes infected with arboviruses in the laboratory, as well as from human skin in a field test conducted in the municipality of São Gabriel da Cachoeira, AM, Brazil, to assess the detection of *Plasmodium*. Artificial intelligence analyses were then applied to diagnose the pathogens.

Results: Our recently published proof-of-concept demonstrates that NIRS can rapidly and non-invasively detect malaria infections through the skin of patients with up to 92% accuracy. Furthermore, it can identify arbovirus infections (dengue, Zika, and chikungunya) and co-infections in *Ae. aegypti* mosquitoes with 90-100% accuracy under laboratory conditions, including arbovirus detection in dead mosquitoes up to 7 days post-mortem.

Conclusion: The NIRS technique simply involves a 5-10 second interaction of harmless infrared light with the sample, skin of human or mosquito, and the use of artificial intelligence to diagnose an infection. The method is rapid, can be portable, delivers real-time results, and has the capacity to screen thousands of samples using unskilled labor without consuming any reagents. Ultimately, our goal is to develop an integrated real-time surveillance and early warning system that utilizes NIRS to guide and concentrate the vector control efforts on high-risk transmission areas (hotspots).

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