An accessible, low cost, hand-held device for detecting counterfeit antimalarial drugs, using quartz crystal microbalance technology.

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Team:

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PhD in microfluidics and acoustics, currently working on a Postdoc in bacterial sensors with the department of Chemical Engineering and Biotechnology. Contributing on designing and integrating the technical components of the device.

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Trained physician, currently pursuing an MBA. Experience as a clinician in the NHS, and holds an Mres degree in Translational medicine. Contributing to experimentation with biological processes, and liaising with medical professionals.

Summary:

Malaria kills approximately a million people each year, and although efforts to produce and distribute effective drugs has increased, there is a growing problem with forged medications. Counterfeit antimalarial drugs cause an estimated 120,000 deaths in Africa per year, and detection methods are too expensive and/or too technically complex. Our objective is the development of a low cost counterfeit drug detection system that can be easily used in low-resource settings. The system builds on open-source quartz crystal microbalance technology to detect the presence of the active drug and its concentration. Easily contained in a handheld device that will give real-time feedback to the user, our method ensures the efficacy of global health measures by contributing to effective malaria elimination in at-risk communities.

Proposal:

i) The Problem: The main problem we are focusing on is the production and distribution of counterfeit ACT (artemisinin combination therapy) drugs. Artemisinin and its endoperoxides derivatives are used in treatment against P Falciparum and P Vivax (Artemisinin Combination Therapy or ACT). The Center for Disease Prevention (USA) in cooperation with Georgia Institute of technology and London School of Hygiene and Tropical Medicine are surveying the scale of ACT counterfeit drugs in Africa (CDC, 2017) and artesunate has been found to be widely faked by the producers both in Africa and SE Asia. It is estimated that fake anti-malarials contribute to nearly 450,000 preventable deaths every year. Our proposed system uses sensors sensitive enough to address multiple problems of counterfeit contents:

a) No active ingredient - malaria is contracted by the user
b) Less active ingredient - parasites are not killed and surviving parasites may become resistant
c) Poor formulations of chemicals or other active ingredients - malaria and other health problems

Our proposed system is also designed as an alternative to current methods which are untenable because of:

a) Cost - GBP 50,000 for mass spectroscopy,NMR; $17,485 for Raman spectroscopy
b) Difficulty of use - Must be highly trained specialist for above methods
c) Transportability - Lab methods waste time and resources, are costly, and require expertise
d) Low-specificity - FDA's CD-3 uses visual fluorescence; paper tests not sensitive enough

ii) Biological System: This system is targeted at the detection of Artemisinin, an anti-malarial drug. Artemisinin is a plant derived drug found in Artemisia annua, also known as sweet wormwood. Its efficacy in the treatment of P. falciparum has resulted in it becoming the standard treatment for this malaria causing plasmodium. To detect this particular analyte we will be using either commercially available antigens or polymer coatings on a QCM-D.

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detect this particular analyte we will be using either commercially available antigens or polymer coatings on a QCM-D.

iii) Design goals of hardware: We aim to refine a number of existing technologies and integrate them to produce a portable, low-cost, rapid detection system for the identification of Artemisinin. This will include: Microfluidic sample preparation on chip; Isolation of target analytes on a QCM-D; Actuation of a QCM-D using affordable low power electronics, and; On-board data analysis and readout for rapid and accessible results.

iv) Implementation: Throughout the project we will liaise with doctors, health professionals and NGOs and foreign aid organisations in order to fully understand the context of the solution and create an effective product with business viability. In creating the product itself, we will:

- Design the device/physical prototype
- Build the components (sensor interacting with sample, intakes, outputs)
- Test the concentration of active component of approved artemisinin sample drug
- Test the concentration of artemisinin in range of counterfeit drugs (or create own compound)
- Compare results confirming viability of QCM-D method
- Create software for ease of input/output and UI for ease of use

v) Proposed Outcomes and Benefits: A low cost and accessible hand held detection device using this technique will prevent health problems and deaths in developing countries, and ensure the effective prevention of malaria, thus improving global health measures. The outcome will prove success of a low-cost adaptable and open source technology (QCM-D) in a new area (drug testing). The benefits going forward are numerous, ranging from preventing counterfeit antibiotics and heart attack medication, to using the device for other medication testing purposes, and even helping combat the trade of recreational drugs.

Components and Budget:

The QCMD sensors to be used in this project will be sourced from a contact in the university, and prototyping of the electronic components will initially use only the provided starter kit. One of the additional ARM platforms would be extremely useful for our QCM actuation and readout circuits. Test analytes such as Artesunate (semi-synthetic derivative of Artemisinin) are available from Sigma-Aldrich from £67 (CAT. NO. A3731-100G).