

Disc-shaped Point-of-Care Platform for Infectious Disease Diagnosis (DiscoGnosis)

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Abstract:

Malaria and infectious diseases of similar clinical symptoms are one of the primary causes of death in endemic areas of the world where numbers denote the extent of the problem (from WHO, 2010): 174 million malaria cases, 80 % of which in Africa, leading to 600 000 deaths. Patients often suffer from different disease than malaria but exhibit similar clinical symptoms, resulting in wrong diagnosis and subsequent maltreatment.

The current “gold standard” diagnostic methods are microscopy smear tests, applicable only to malaria, and Rapid Diagnostic Tests (RDTs), available for other infectious diseases too. The latter are often preferred due to their low cost-per-test. On the other hand, each test detects only one disease; therefore, if the patient is found negative to malaria, more than one (disease-specific) RDTs need to be employed, which significantly increases the cost-per-patient.

DiscoGnosis aims at developing a fully-automated diagnostic platform for point-of-care use, keeping the cost-per-patient close to RDTs’ level. The platform is based on a disc-shaped microfluidic cartridge (LabDisk, Fig.1a), wherein the fluids are transported by centrifugal forces using a dedicated LabDisk reader (Fig.1b), the latter performing the detection too. Some of the key technological advancements are:

Fully automated sample-to-answer analysis: Minimum external intervention is achieved via: (i) universal adaptor for patient-to-disc interface and sample (whole blood) loading; (ii) utilization of microfluidic unit operations in order to transfer assay protocols from tube to disc: fluid pumping, mixing, metering, aliquoting, reagent storage, and bead handling are integrateable on disc in the form of individual, interfaceable modules.

Multiplexing: (i) On pathogen level, a variety of pathogens will be probed on the same disposable cartridge: parasites (malaria); bacteria (typho and pneumonia); viruses (dengue); (ii) on assay level: dual approach with highly specific immunoassays and isothermal nucleic acid amplification in order to broaden the diagnostic window; (iii) on detection level, using quantum dots (QDs) as detection agents.

Production technology: The discs are fabricated via microthermoforming of polymer foils, a technology adapted from the macroscale (blister package production) to the demands of microscale features.

The developed system will be validated in clinical settings at the areas of need, in local hospitals in Africa via partners’ established contacts. The development steps take into account local particularities such as high temperature and humidity, frequent electricity cuts etc, but consider also the general

applicability of the system in developed countries. The results will be compared with the “gold standard” methods used for the examined diseases in order to assess the reliability of the system.



(a)



(b)

Fig.1. (a) Foil-based disc-shaped microfluidic cartridge where some fluidic features are visible. (b) The LabDisk reader, integrating user-defined rotating frequency and temperature protocols as well as a detection unit.

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