Project Details	
Project Code	MRC21NMHBa Reis
Title	Development of a rapid biosensing methodology for “fingerprinting” endocrine and immune responses to stress
Research Theme	Neuroscience & Mental Health
Summary	Neurophysiology and health psychology research identified the mechanisms of response to stress, with the allostatic load pointing to a physiological ‘wear and tear’ leading to dysregulation and poor health. This project will combine expertise in microfluidic diagnostics and neurophysiology to deliver a transformative biosensor profiling key stress hormones and inflammatory biomarkers, for monitoring response of the nervous, endocrine and immune system to stress.
Description	Decades of intense research on neurophysiology and psychology identified the mechanisms of response to stress, with the theory of “allostatic load” suggesting an accumulated physiological ‘wear and tear’ leading to dysregulation and poor health. Current procedures for measuring stress hormones and inflammatory cytokines are too laborious relying on bulky sophisticated lab equipment and complex sample preparation. We hypothesise that a simple rapid optical test for ‘fingerprinting’ endocrine hormone and inflammatory biomarkers with the use of a smartphone would speed up diagnosis of endocrine disorders; reduce cost of intervention for patients undergoing therapeutics; enable health psychologists to make more rational decisions; enable neuroendocrine researchers to study more effectively the links of neuroendocrine system with chronic diseases; and provide clinically important information in areas of the world with poor laboratory services. This project brings together a world-leading supervisory team from Biomedical Engineering, Neuroendocrinology, Supermolecular Chemistry and Health Psychology with a track record of supervision of multidisciplinary research projects for delivering a transformative biosensing methodology for a new generation of rapid diagnostic tools tuned to Neurosciences and Mental Health. The project would suit a creative, curious and self-motivate student with background in Biomedical Sciences, Chemistry, Chemical Engineering or Biomedical Engineering or any other relevant science. To validate the research hypotheses, the project will focus on 3 main activities as described below. Firstly, we will synthesise and screen new biosensing reporter molecules generating an optical signal upon displacement of hormone/biomarker from the binding cavity in the receptor (antibody or aptamer), enabling one-step quantitation of hormones. We will prioritise ‘switch-on’ fluorescence reporters that can be easily incorporated in a disposable device and provide optimum signal-to-noise ratio; however a ‘switch-off’ reporter can be incorporated into non-invasive devices (e.g. a patch for continuous monitoring of hormone from sweat). The targeted hormones and biomarker’s panel will be based on a SWOT analysis, NHS statistics data and expertise of supervisory team, but the initial focus will be a displacement assay for quantitation of cortisol and C-reactive protein. We will characterise the probes using molecular and spectrophotometer imaging techniques and in-flow NMR. Secondly, we will integrate the new displacement assays into miniaturised devices (3D printed, photolitography and melt-extrusion). The design of the

	device will be driven by the targeted sample to be measured and sensitivity of the test, as hormones are present at very distinct concentrations in different human body fluids. For example, the "Lab-on-a-stick" approach pioneered by Reis et al (Lab on a Chip, 2016) can be quickly adapted to one-step quantitation of hormones from saliva, urine and a finger-prick, and other devices embedded within a 'skin patch' will be fast-prototyped for quantitation from sweat, for which a microfluidic device embedded within a 'skin patch'. We will access state-of-the-art nano- and micro-fabrication facility, surface characterisation and microscopy and imaging facilities. Manufacturing and performance of the devices can be assisted by CAD, Computational Fluid Dynamics (CFD) simulation tools and optical imaging and fluorescence imaging, including confocal microscopy all available on-site. Thirdly, we aim at testing the methodology in endocrinology and health psychology, and benchmark against current analytical methodology (ELISA and MS). We aim to test the methodology with healthy patient samples and carry out testing in a small group of volunteers in order to deliver impact during the time scale of the PhD project.
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