

Development of a biosensor for chairside- and self- diagnosis of oral candidiasis in the elderly

For consideration in the joint award “Manchester Metropolitan University/MICRA”

Project team:

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Candida albicans is a dimorphic fungus capable of causing denture stomatitis, the most common form of oral candidiasis, present in up to 60% of denture wearers, affecting predominantly patients over 65 years old. Symptoms include mucosal bleeding, swelling, burning and other painful sensations, halitosis, unpleasant taste and dryness in the mouth (Dorocka-Bobkowska et al., 2010). Oral candidiasis more commonly occurs with denture wearers compared to non-denture wearers (Daniluk et al., 2006), and systemic infection can result from this initial superficial infection (Hebecker et al., 2014). Oral candidiasis in general is associated with risk factors including but not limited to diabetes type 1 and 2, severe anaemia, systemic immunosuppression and avoidable factors such as poor dental hygiene, local trauma, malnutrition, smoking and drug use. A positive diagnosis for candidiasis can be an indicator of one or more of these risk factors (NICE, 2013a) – many of which can accompany ageing.

The diagnosis and of oral candidiasis often relies on visual inspection for clinical features, with NICE suggesting the use of image banks such as <http://www.dermnetz.org/topics/oral-candidiasis/>. Symptoms presenting themselves with oral candidiasis can also be present in other diseases or conditions such as leukoplakia, erythema migrans or hairy tongue, making a confirmatory diagnosis on visual inspection alone difficult. Additionally, to assist confirmation, the mouth and/or denture can be swabbed and cultured (taking upwards of 24 hours), at an additional cost to the NHS – and with a time implication.

Currently, miconazole and fluconazole are indicated as first choice medication for oral candidiasis (NICE, 2013b). However, there are an increasing number of resistant strains of *Candida* species able to survive both miconazole and fluconazole (Chandra et al, 2001, Flevvari et al., 2013, Hitchcock et al, 1993). Therefore, chairside diagnosis using a sensor would provide a rapid, confirmatory diagnosis, enabling more confident prescription of appropriate treatment. Indeed, a simple sensor might also enable self-diagnosis, or carer-diagnosis, speeding up accurate diagnosis, reducing clinic/dentist visits and enabling more targeted drug prescription.

Like most other fungi, *C. albicans* is capable of producing microbial volatile organic compounds (MVOCs), with over 150 described in the literature. Previous research carried out by Professor Joanna Verran at Manchester Metropolitan University in the elite research group Microbiology at Interfaces has shown that MVOCs produced by fungi, including *C. albicans* growing on denture material, are identifiable with solid phase micro-extraction (SPME) and gas chromatography-mass spectrometry (GC-MS). Additional work by Verran in collaboration with the elite research group Advanced Materials and Surface Engineering (Professor Craig Banks) resulted in the development

of one-shot disposable sensors capable of detecting MVOCs from fungi (Bingley et al., 2012), whereby MVOCs interact with an electrode known as 'ink' (consisting of graphite particles, a polymer binder and other additives) which change depending on the amount of compound detected. This allows sensors to be developed for a range of compounds (MVOCs) and allows a relative level of quantification of MVOC present.

Phase one of this project would bring together expertise from Manchester Metropolitan University and University of Manchester to achieve the following objectives:

- Isolation of clinical strains of *Candida* species from elderly patients at the University Dental Hospital of Manchester
- Molecular characterisation of clinical strains
- Identification of MVOC profile and key elements from a sample of clinical strains
- Investigate the sensitivity/limit of detection of potential biosensor relating to the clinical isolates and MVOC profile