

Project Details	
Project Code	MRC23IIARCa Williams
Title	Investigating the therapeutic potential of microwaves in chronic wound healing
Research Theme	Infection, Immunity, Antimicrobial Resistance and Repair
Summary	Chronic wounds are a significant economic and societal burden. Bacterial biofilms are regular colonisers of chronic wounds, with treatment failure common. Microwaves will be investigated as a potential therapy for chronic wounds via a dual approach of biofilm disruption and promoting healing through fibroblast stimulation. A clinical prototype will also be designed based on patient feedback and an interdisciplinary skillset will be developed.
Description	<p>Chronic wounds are a significant societal problem, expected to increase as the population ages and co-morbidities such as obesity and diabetes become increasingly common. Currently 4% of the total NHS budget is used in treating chronic wounds and their infections. Most of the burden is within general practise, consuming 25-50% of community nurse time. More than 80% of wounds show colonisation with bacteria, thought to be a major contributor to wound chronicity. Biofilm formation is a strategy used by bacteria to persist in wounds. Four of the top five wound-associated bacteria are classified as high/ critical priority antibiotic resistant pathogens by the WHO. Treatment failure is thus common. Microwave-based therapeutics, already routinely used in tumour ablation and minor skin conditions (e.g. verrucae) have proven efficacy and safety records clinically. Our preliminary work shows that low-level microwave energy is effective in inhibiting the growth of <i>Staphylococcus aureus</i>, commonly associated with chronic wound infections. Microwaves have not only been shown to modify microbial populations but are also able to stimulate proliferation and migration of healthy fibroblasts, promoting wound healing. Research questions: 1. Can microwaves disrupt bacterial biofilms associated with chronic wounds, leading to enhanced antibiotic efficacy? 2. Can microwaves augment the wound healing process through stimulation of healthy or chronic wound fibroblasts? 3. How can we deliver microwaves safely and effectively to heal chronic wounds in a clinical setting? Objectives: 1. Early-phase patient and public engagement to assess acceptability of microwave-based therapeutics and capture insight to inform technology design. The ultimate long-term ambitions of this project are to implement microwave technology in a clinical wound healing setting. To achieve this, we plan to involve the end-users of the proposed technology (i.e. chronic wound patients and members of the public) from an early stage in order to scope their opinions on wearable technologies. This will be achieved through initial Patient and Public Involvement (PPI) sessions to scope these areas and help co-develop an informative multi-modal survey. 2. Microwave treatment regime (in vitro). Determine the optimal microwave parameters for: (i) biofilm disruption and synergy with antibiotics, focussing on the top 2 wound-associated pathogens: <i>Staphylococcus aureus</i> and <i>Pseudomonas aeruginosa</i> comparing clinical and non-clinical isolates, as well as broad-spectrum antibiotics commonly prescribed to treat wound infections. (ii) Wound healing using healthy and chronic fibroblast cells. 3. Mode of</p>

	<p>action studies (in vitro). (i) Detailed growth, microscopic (via scanning electron microscopy, confocal microscopy and atomic force microscopy), membrane integrity and biochemical (reactive oxygen species) studies to determine the mechanism of microwave-induced effects. (ii) Challenge studies to determine whether microwaves affect the ability of bacteria to infiltrate fibroblast cells and enhance the ability of fibroblasts to eliminate bacteria. 4. Technological design: Microwave applicators have already been developed and validated by our team for the in vitro investigations described above. However, these applicators will need further refinement for future clinical use. The student will scrutinise the current literature and market for current clinical microwave applicators, seek the opinions of medical experts (e.g. Welsh Wound Innovation Centre) and industry experts in this field (e.g. Emblation) and use this information to design a bespoke microwave applicator specifically for wound healing applications. This interdisciplinary project will allow the student to expand their skillset into new areas of interest. The student will be encouraged to develop their own project-related ideas and interests and participate in local and national research networks.</p>
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