Project Details	
Project Code	MRCIIAR24Br Su
Title	Multifunctional urinary catheters to monitor and control biofilm formation
Research Theme	Infection, Immunity, Antimicrobial Resistance & Repair
Summary	The care of catheterised patients is frequently complicated by bacterial infection and biofilm formation, which leads to serious complications for patients. Working with a multidisciplinary team of materials scientists and microbiologists, you will employ a wide range of chemical and biological methods to develop and evaluate novel technologies for control of catheter infection, including alternatives to conventional antibiotics.
Description	Urinary catheters are commonly used to manage long-term conditions in individuals cared for in the community. Although long-term catheterisation can provide many benefits these are often undermined by infection and catheter blockage. Blockage is primarily due to formation of crystalline biofilms by Proteus mirabilis. The potent urease activity of this bacterial pathogen elevates urinary pH causing precipitation of calcium and magnesium phosphates from urine. These microcrystalline aggregates become incorporated into developing biofilms on catheter surfaces, resulting in a mineralised biofilm structure that blocks urine flow. Catheter blockage leads to serious clinical complications such as pyelonephritis and septicaemia, but is often not detected until these dangerous conditions arise. Currently all available catheter types are vulnerable to P. mirabilis encrustation, and there is an urgent need for new technologies to address this problem. Recently we have developed new techniques to augment existing catheters to incorporate novel bioactive agents, or provide early warning of blockage, and initial proof-of-concept experiments have demonstrated the potential for these approaches to control blockage. This project will build on this work to enhance strategies for biofilm control, provide fundamental insight into biocompatibility, and develop "theranostic" catheter prototypes that can simultaneously prevent blockage and provide advanced warning to patients and carers. Key objectives are: Objective 1: Encrustation resistant catheters. Initial work will focus on developing and evaluating strategies for modifying existing catheters to control encrustation. Approaches will focus on preventing crystal formation by incorporating novel alternatives to conventional antibiotics that modulate catheter surface pH, inhibit urease activity, or reduce bacterial adhesion and inhibit biofilm formation. These approaches will be evaluated using our in vitro models of catheter infection, and associated approaches for biofilm analysis. Objective 2: Early warning systems for catheter blockage. Building on our previous work, we will explore the potential to provide patients and carers with advanced warning of the potential for blockage. This work will focus on developing multifunctional catheters using novel hydrogel infusion approaches. Incorporation of hydrogels into catheters in this way may directly inhibit encrustation, but also provides a reservoir for additional cargo molecules. These include pH indicators that can provide a visual signal of urinary of pH changes associated with P. mirabilis infection and crystal formation. Our in vitro infection models will again be used to evaluate

	this approach. Objective 3: Theranostic catheters and evaluation in polymicrobial infection models. Our most promising encrustation control and early warning approaches will be combined to develop theranostic catheter prototypes. Evaluation of these catheters will utilise novel polymicrobial models of catheter infection, which contain reproducible microbial communities encompassing the most common uropathogens. These models will be used to evaluate catheter performance in a range of infection scenarios, from early colonisation to established infection. Alongside cytotoxicity testing, this facilitates the robust preclinical evaluation of novel catheter technologies, and allows important fundamental insight into the impact of catheter modifications on a range of common uropathogens. Student Ownership The student will be supported to take ownership of the project from the outset. The supervisory team will enable the student to lead on experimental design and the focus of objectives and work conducted. Initial "prep-period" activities and training will enable the student to more specifically define the research questions and lead implementation of experiments to test hypotheses they develop.
Supervisory Team	
Lead Supervisor	
Name	Professor Bo Su
Affiliation	Bristol
College/Faculty	Faculty of Health Sciences
Department/School	Bristol Dental School
Email Address	b.su@bristol.ac.uk
Co-Supervisor 1	
Name	Professor Brian Jones
Affiliation	Bath
College/Faculty	Faculty of Science
Department/School	Department of Life Sciences
Co-Supervisor 2	
Name	Dr Angela Nobbs
Affiliation	Bristol
College/Faculty	Faculty of Health Sciences
Department/School	Bristol Dental School
Co-Supervisor 3	
Name	Dr Maisem Laabei
Affiliation	Bath
College/Faculty	Faculty of Science
Department/School	Department of Life Sciences