ANTI-INFECTIVE CATHETER FABRICATION THROUGH ADDITIVE MANUFACTURING

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Background: Catheter associated infections (CAI) are one of the most common issues associated with patients on dialysis. The present approach to prevent CAI involves the use of coated catheters, which are often coated with heparin, silver nanoparticles or pyrogallol. Coatings add another step to the manufacture process and also require a balance between thickness of coating and sufficient drug release. In this project, we set out to create catheters using additive manufacturing (AM) for the first time to our knowledge, specifically by Fused Deposition Modelling (FDM) 3D Printing. AM offers the potential to create patient specific catheters, with the potential to varying the drugs loaded in the filaments through hot-melt extrusion (HME).

Methods: Antimicrobial filaments were created using HME, which is a common process used to create filaments for FDM by combining pressure and heat to melt polymer pellets, with the possibility of addition of drug. Tetracycline (TC) was mixed with thermoplastic polyurethane (TPU) pellets and extruded to form filaments with antimicrobial properties. TC concentrations of 0.25, 0.5 and 1% were used. Designs were made using computer aided design (CAD) and sliced using Cura software. The antimicrobial filaments at varying concentrations were used to print the catheter designs using the Ultimaker 3 FDM printer. Release studies were carried out using the printed catheter constructs in phosphate buffered saline (PBS), microbiology studies, thermal analysis, contact angle goniometry (CAG), attenuated total reflection-Fourier transform infrared (FTIR) spectroscopy, scanning electron microscopy (SEM and X-ray microcomputer tomography (μCT) analysis were conducted on the printed catheters and TC containing TPU materials.

Results: Results showed that there was sustained release of TC from the catheters over a 2-week period with around 4% of the total drug load being released after 10 days and the drug was evenly distributed throughout the TPU matrix. Microbiology results showed that the catheters had an inhibitory effect on *Staphylococcus aureus* NCTC 10788 bacteria and prevented the bacteria adhering to their surface. Furthermore, catheters containing 1% TC maintained inhibitory effect after 10 days of releasing TC in PBS and also presented a reduction in bacterial adherence of up to 99.7%.

Conclusions: The results in this study shows that TC can be effectively added to TPU to produce 3D printed antimicrobial catheters. Only one application of this process is outlined above, different drug eluting materials can be created using the same method and later used to created medical devices by 3D printing.