



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Ishaan Brar	Project Number S1205
Project Title A Novel Multi-Lumen Urinary Catheter with Sustained Unidirectional Biocide Flow	
<p style="text-align: center;">Abstract</p> <p>Objectives Urinary catheter is the most common indwelling catheter used worldwide. It is used to drain urine from the urinary bladder into a collection bag to relieve urinary obstruction. It is a tube (catheter) with the diameter less than that of human urethra. It has 2 lumens, larger one is used to drain the urine, while the smaller one is used to inflate a balloon in the bladder which prevents accidental dislodging of catheter. The catheters are a major source of infection, resulting in 13,000 deaths in US and over 250,000 annually worldwide, costing 24 billion a year. Infection starts in the inner lining of catheter and is related to biofilm formation. Biofilms are difficult to eradicate because of bacterial organization and resultant resistance to biocides. The novel catheter was designed and prototyped with the objective to prevent biofilm formation. The hypothesis was that the multi-lumen catheter, one-way valve and pumping mechanism would allow sustained instillation of biocides into the catheter lumen without backflow into the bladder, thus preventing biofilm formation.</p> <p>Methods After sketching the catheter design, and then employing auto CAD and 3D printing techniques, a silicon-based catheter prototype was made. This novel catheter design had multiple channels, a mixing chamber at the insertion end, and a one-way valve at the tip. With this design, the biocide could be introduced, or pH could be altered within the urinary lumen of the catheter without effect on the urinary bladder. Essentially, the conditions within the lumen of the catheter could be modified so they were not conducive to bacterial growth, help remove the biofilm in the lumen and prevent the growth of bacteria in the urinary collection bag. Pressure dependent biocide delivery system ensured that there was a sustained or a cyclic introduction of biocide at a controlled rate into the urinary lumen of the catheter. The testing apparatus was also 3D printed to perform in-vitro testing and to demonstrate functioning of the design.</p> <p>Results Biocide in the form of alkaline fluid, with pH of 11.5, was instilled into the catheter lumen. Acidic fluid with a pH of 6.5 was instilled into the bladder lumen. The pH of fluid in the collection bag and in bladder lumen was measured every 3 hours for 12 hours. Results showed that the pH maintained at 6-6.5 in bladder and 11.4-11.6 in the collection bag.</p> <p>Conclusions It demonstrated multi-lumen catheter and the one-way valve functioned as hypothesized. These modifications in the catheter design could potentially lead to significant reduction of UTIs, sepsis and mortality and help save millions of healthcare dollars. Other catheters like triple-lumen catheters and PICC</p>	
Summary Statement A novel design of a urinary catheter that can prevent biofilm formation and reduce urinary tract infections.	
Help Received Mentor: Harjeet Brar, MD. -supervised project, transcribed sketches into Auto-CAD, uploaded designs to 3D printer. Student sketched diagrams, thermoformed and created non-3D printed mechanism, created testing device and catheter with supervision, performed the tests.	