Naturally 3D Printing Away Fatal Catheter-Associated Urinary Tract Infections, Year Two

Sampson, Mitchell (School: Northview High School)

In the U.S., catheter-associated urinary tract infections (CAUTIs) are responsible for 449,334 diagnoses/yearly, 13,000 deaths/yearly, and medical expenses of over $450 million/yearly. The cause is estimated to be E. coli 90% of the time, and approximately 18% of those strains are extended-spectrum beta-lactamase (ESBL)-producing, which is resistant to many antibiotics, such as penicillins and third generation cephalosporins. The engineering goal of this project was to use custom 3D printing and oregano essential oil (OEO) to create affordable, mass-producible, novel catheter inner lining designs that, compared to a control, would also reduce bacterial biofilm formation, lessening the risk of CAUTIs. OEO was chosen due to cost-effectiveness and its two major constituents, carvacrol and thymol, possessing a myriad of antibacterial properties that have shown effectiveness against even ESBL-producing E. coli strains. The first catheter prototype invented was modeled with focus on both fluid dynamics and synergistically-utilizing OEO. The second prototype was designed to optimize the contributions from the hydrophilic gels while remaining structurally sound because of its triangle-based architecture. Both prototypes were each printed three times without error using an incredibly ideal resin, DuraForm PA Nylon, for this application; furthermore, testing was then done with an E. coli inoculated, urine-simulating broth to judge the prototypes' CAUTI-prevention effectiveness by themselves, then with only a glycerin gel coating, and with a specially made OEO gel. The results underwent t-test analyses: highly statistically significant p-values affirm the achievement of the engineering goal and support the experiment's undeniable success.

Awards Won: