

**“Smart” Coatings:  
A Novel Implant Coating to Deliver Antibiotics Through An Active Trigger Mechanism**

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**Introduction:** Endoprosthetic infections are devastating, often threatening both life and limb. Current methods of local antibiotic delivery are short-lived (vancomycin powder) or via passive release from biologically suboptimal vehicles (antibiotic-loaded beads). The goal of this project was to develop a biodegradable, “smart” polyethylene glycol (PEG) coating that would actively release antibiotics when challenged with bacteria.

**Questions:** 1) Can we develop a polymer that protects the implant surface from biofilm formation?

2) Can we design the coating to “intelligently” release antibiotic when challenged by the presence of bacteria?

3) Can we demonstrate efficacy *in vivo* in an established mouse model of implant infection?

**Methods:** We developed a polyethylene glycol-polypropylene sulfide (PEG-PPS) vehicle coating that can deliver antibiotic payloads through passive elution at above the minimum inhibitory concentration (MIC) of *S. aureus*, *S. epidermidis*, and *P. acnes*. We then modified the coating to increase release of antibiotics in response to a lowering pH, a product of reactive oxygen species-driven tissue change to infection. After *in vitro* verification of the active-passive release mechanism, we employed an established mouse model of post-operative spinal implant infection to test the *in vivo* results of this coating. Six mice received an implant coated with PEG-PPS polymer alone, 6 received Tigecycline-embedded PEG-PPS (Tig), and 6 received Vancomycin-PEG-PPS (Vanc). The implants were inoculated with  $1 \times 10^3$  colony forming units (CFU) of bioluminescent *S. aureus* after implantation. Bacterial burden was tracked longitudinally with quantitative bioluminescence and imaging up to postoperative day (POD) 21. At the end of the experiment the implants and surrounding tissue were extracted and cultured.

**Results:** PEG-PPS was confirmed to release antibiotic both passively and actively, in response to lowering pH. Both the Vanc and Tig groups had lower bacterial bioluminescence signals in comparison to the control group throughout the 21 day post-operative period, showing the coating was successful at combating infection. The Vanc group signal was significantly lower than the control throughout the entire period, with infection of the implant undetectable ( $p < 0.05$ ). Implant and tissue CFUs were undetectable in the Vanc-PEG-PPS group ( $p < 0.05$ ).

**Conclusions:** PEG-PPS is an optimal vehicle to deliver antibiotics in the setting of endoprosthetic implants as it passively delivers antibiotics above the MIC and actively increases drug delivery in the presence of bacteria. The Vanc impregnated PEG-PPS coating prevented implant colonization by bacteria and prevented implant infection completely. This novel coating shows promise in the prevention and/or treatment of oncology implant infections and further large animal studies and biosafety studies are warranted.

### *S. Aureus* Bioluminescence

