Comparative Evaluation of Electrical Strategies for Eradication of Staphylococcus epidermidis Biofilms

Electricity is a proposed treatment for biofilms. I compared three electrical approaches to treat bacterial biofilms: passage of current through/across biofilms, an electric field, and direct application of current. 12 rods each of titanium and stainless steel were constructed. Staphylococcus epidermidis biofilms were grown on the whole rod or one end, treated with electricity in a dilute solution of trypticase soy broth and 0.45% saline or a phosphate buffer, and quantitatively cultured. To assess the effect of passing current through/across biofilms, 0.1, 0.5 or 5mA of current was passed through stainless steel or platinum electrodes placed on either side of stainless steel rods or from electrodes to the rods. After 1 day, 3.7x10^4-2.2x10^6 cfu were measured on control rods. 0.5 and 5 mA delivered with stainless steel electrodes yielded no growth and 0.1 mA yielded 0-8.7x10^3 cfu. With platinum electrodes delivering 0.1 mA, 0-2.5x10^4 cfu were measured. An electrical field (143.8V/cm potential, 2 days) applied to stainless steel rods resulted in no significant change in biofilm quantity. Likewise, direct application of current end-to-end through titanium (15MHz,6V,100/1,000/10,000ohm resistors, 2 days; 1A,0.131V, 1 day; +/-1Amp in 20mA steps, 1 and 8 days; 275mV,50MHz, 2 and 4 days; +/- 5V, 5 days) and stainless steel (+/-5V,40MHz, 5-7 days) rods yielded no significant decrease in biofilm quantity. Although there was no effect measured using direct application of current or an electric field, delivery of current through/across biofilms was an active anti-biofilm strategy (p=0.016). Passage of electrical current through/across biofilms is a promising anti-biofilm strategy.

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