Surface treatment for improved inhibition of microbial surface colonization: laboratory to real-world application

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Background. Two challenges common to most disinfection programs are to ensure sufficient contact time for effective killing of microbial cells and to reach all potential sources of contamination. Adding to the problem is that once growing as biofilms, most microorganisms show significantly higher resistance than cells in suspension – this increased resistance is often attributed to persister cells at the biofilm – surface interface, protection offered to the cells by the associated EPS (extracellular polymeric substance) matrix through increased mechanical stability or as a diffusion barrier, and phenotypical changes related to biofilm formation. A consequence of the failure of conventional chemical and physical programs to reach or inhibit cells in this region is the rapid recovery following treatment. In order to address this problem, much emphasis has been placed on the development of technologies to prevent biofilm accumulation, such as nonfouling materials with inherent antimicrobial properties and protective coatings. While nonfouling materials find use in specialized niche markets, they may not be feasible in larger applications due to cost. Nano-coatings too are often expensive, or can be applied only in specialized facilities, or rely on sufficient leaching in order to be effective.

Comparing clinical and environmental bacterial species, we found a strong correlation between multidrug-resistant (clinical) pseudomonad strains and mixed-community biofilms occurring in selected areas in intensive care units[1]. These biofilm communities showed a remarkable ability to rapidly recover after biocide treatment, effectively incorporate test opportunistic pathogens in laboratory experiments, offer increased protection to the incorporated pathogens against antimicrobial treatment at levels that kill suspended cells[2], and serve as a proliferation mechanism that release cells back to the environment[3]. In a clinical context, these results support the notion that environment-to-patient transfer should be considered a mechanism for the spread of pathogens in addition to the conventional emphasis on patient-to-patient transfer. A similar argument can be made for pathogen transfer in public spaces and contamination / spoilage bacteria in food processing and other industries.

Approach. In view of our results demonstrating environmental surfaces as sources of free-living bacteria, we focus on preventative inhibition of microbial surface growth using an alternative non-leaching nano-technology as part of standard operating procedure - opposed to reactive disinfection of existing biofouling. We evaluated and further developed the bio-static surface protectant AM500 in laboratory settings and showed its efficacy against a number of test bacteria following a new protocol specifically developed to evaluate inhibitor efficiency on hard surfaces (stainless steel, plastic, glass), in combination with standard laboratory methods as well as scanning confocal laser and scanning electron microscopy. Linen was used as an example of a porous surface and the protectant bound irreversibly to this fabric without significant loss of efficacy after 25 wash cycles in an industrial laundry facility. These findings and tests in food processing facilities, hospitals and public areas demonstrate the utility of this approach. Even though it is nearly impossible to have a 100% prevention of bacterial surface colonization with any product currently available and safe for use, incorporating microbio-static molecules with existing cleaning procedures greatly reduces the occurrence of microorganisms on surfaces thereby achieving improved levels of hygiene and subsequently, mitigating infection and contamination. Combined with the ease of application, cost effectiveness and demonstrated inhibition efficacy, this stable, environment friendly microbial inhibitor offers an attractive strategy to alleviate spoilage of food and other products, and provides an effective extra layer of protection against human pathogens. This is especially relevant to public spaces, clinical and care facilities, as well as workers housing and other instances where people are confined to close quarters such as mining operations and oil rigs.

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