



An Analysis on the Inhibition of Quorum Sensing in *Pseudomonas Aeruginosa* to Prevent Biofilm Formation

Victor Cuevas-Elias, My Lao Thao, PhD
CSU Stanislaus

Introduction

Ever wonder why one's teeth feel slimy after brushing or how dental plaque forms or even what plaque is? It all comes down to the formation of what are called biofilms. They are the formation of layers upon layers of all kinds of species of microorganisms that coexists to thrive and adapt to their immediate or surrounding environment. "Communication or known in the microbial world as quorum sensing is described as the production, dispersal, and receiving of chemical signals named auto inducers" (Oleskin and others, 2010 O'loughlin, Miller, Siryaporn, Drescher, Semmelhack, & Bassler, 2013). Due to quorum sensing the normal flora in our body that attach to surfaces allow for other pathogenic bacteria to also bind and adapt. By the adherence of normal flora to surfaces for survival, protection, and nutritionally beneficial. Through the use of quorum sensing bacteria can pass on their genes but can also pass on information about their environment such as traits that need to be expressed more than others, whether they should conserve their food, hibernate, or spread.

The key to the disruption of biofilm formation leads back to the prevention of quorum sensing. This method of action although shown to be effective is not specific bactericidal against *P. aeruginosa* and therefore, its generality can pose a hazard of drug resistance. Instead the better alternative would be a form of protective coating that will cover medical devices and/or surfaces biofilms are known to form on. Biofilms especially those preeminent with *P. aeruginosa* pose a great hazard that can cause hospital acquired infections with high resistance to antibiotics. The proposed solution suggested by the evidence is to use a nanoparticle covered medical device or surface to prevent attachment of the microbe while including multiple inhibitors, used in a rotating series, for quorum sensing.

CONTACT

Victor Cuevas-Elias
Honors Program
Email: vcuevaselias@gmail.com :

Research Question

How to reduce the number of hospital acquired diseases?
How to reduce the prevalence of biofilms, especially in a hospital setting?
How to reduce the mutation rates between *Pseudomonas aeruginosa*.

Background and Literature Review

If there were certain genes that allowed a microbe to better attach to the surface or other bacteria to form a community, then its genetic information would be exchanged with other microbes for better formation of the biofilms (Kolenbrander, 2011).
As the microbes undergo certain stresses it can have an effect on our body's chemical signals such as catecholamine increasing the normal microbiota and attachment ability of those microbes to the surface, while serotonin also increases the number of the normal microbiota (Oleskin and others, 2010).
Pseudomonas aeruginosa was used in an experiment to inhibit biofilm formation through preventing quorum sensing with a chemical named meta-bromo-thiolactone, which prevents two key receptors from functioning properly, LaSR and Rh1R (O'Loughlin and others, 2013).
As the study performed by Francesko, Fernandes, Ivanova, Amorim, Reis, et al. suggests, a silicone surface built in a layer by layer manner will be the most effective to preventing biofilms from forming; this is done by creating a water friendly environment that makes it difficult for *P. aeruginosa* to build a foundation from (2016).
As a low cost alternative it can prevent the formation of biofilms by preventing attachment to a surface and changing the overall structure of biofilms to make it un-operational (Yu, Li, Zhang, Wen, Liu, et al, 2016).

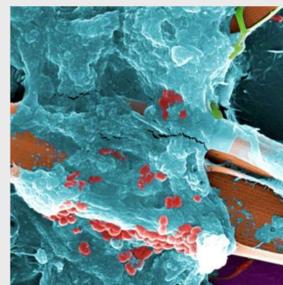


Figure 1. Biofilm Formation.

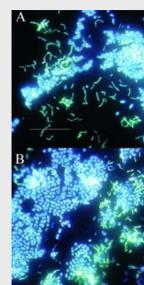


Figure 2. Fluorescent Microscopy view of Biofilm Formation.

Methods

The subject of study will be looking at biofilm formation and implementing a hypothetical solution for prevention of attachment and quorum sensing. Due to the limited resources and time an actual study with the proposed solution will not be done, instead an analysis will be done with the available studies. The participants in the study will be colonies of *Pseudomonas Aeruginosa*. A hydrophilic nanoparticle based surface will be combined with enzymes that will inhibit quorum sensing. Therefore, prevention of attachment will occur while the enzymes and antimicrobial agents will help to prevent the remaining microbes from developing the biofilms. A silicone coating was developed and showed promise to be an effective surface as it removed many of the biofilms of *P. aeruginosa* however, it opened room for a different type of microbe to develop its own biofilm. A nanoporous surface was instead proposed, which will prevent further attachment of a wider range of biofilm creating microbes. With the addition of antimicrobial agents that are known to inhibit or inactivate the ability to perform quorum sensing and biofilm formation. meta-bromo-thiolactone, which prevents two key receptors from functioning properly, LaSR and Rh1R; and D- Tyrosine a type of amino acid and sugar that is a more natural chemical to combat the attachment of microbes. Lastly, a cyclase which breaks some fatty acid chains, 3-oxo-C12-L-HL, a key component to the activation of biofilm formation. The 3 antimicrobial agents would work more efficiently if they were implemented in a rotational series.

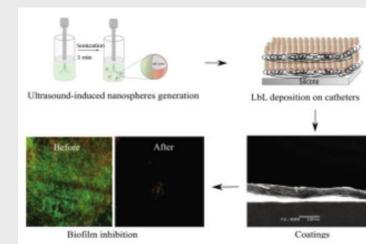


Chart 1. Protective Coating

Expected Conclusions

Based on the proposed solution the results will show a major decrease in the biofilm formation since *P. aeruginosa* will not bind to the surface which will prevent quorum sensing from occurring. The fluorescent microscopy will be able to visualize the prevention of attachment while an incubation and streaking of the tested surface will show few if any bacterial colonies developing. Thereby having the evidence display prevention of attachment and inhibition of quorum sensing to be the better solution against biofilm formation.

Significance

This analysis will further the knowledge and piece together studies that have been done before to show how effective preventing quorum sensing will be against biofilm formation. Which in hope will spur further studies and developments against the growing threat of biofilms and make hospital acquired infection from medical devices just a part of history.

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