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Opinion Article

The Development of Biofilms during Acute Infections

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DESCRIPTION

Bacterial biofilm development has long been recognised as important in persistent bacterial lung infections. Similarly, persistent biofilm development on medical equipment is widely recognised as a source of recurrent bacteremia. Despite the fact that the dominant paradigm relies on the prevalence of planktonic bacteria in acute endobronchial infections, our understanding of bacterial organisation during acute infection is inadequate if not non-existent. Moreover, by comparing identical clinical data, we recently discovered significant bacterial biofilm development during acute lung infections that is similar to the massive bacterial biofilm formation during chronic lung infections. These findings call into question the fundamental concept that chronic infections are dominated by biofilm-forming bacteria whereas acute infections are dominated by planktonic bacteria.

In contrast to the substantial quantity of bacterial biofilm detected in both chronic and acute lung infections, we discovered that quick bacterial growth in acute lung infections varied from sluggish bacterial growth in chronic lung infections. We explore strategies of enhanced biofilm infection therapy and the relevance of bacterial growth rates for other bacterial biofilm infections than human lung infections by highlighting these recent results. For protection from harmful external stimuli, microbial cells adhering to inert or alive surfaces form a biofilm with a self-produced exopolysaccharide matrix including polysaccharides, proteins, and extracellular DNA. Biofilms in hospitals and factories serve as a breeding ground for drug-resistant bacteria and ARG enrichment, both of which are associated with pathogenicity and obstruct industrial production processes. Quorum Sensing (QS), a method of bacterial cell-to-cell communication for cooperative physiological functions, regulates biofilm development, including virulence and pathogenicity.

As a result, QS suppression by Quorum Quenching (QQ) is a viable technique to inhibiting biofilm development. Biofilms, on the other hand, have important functions in fostering plant development, biocontrol, and wastewater treatment. Polymicrobial biofilms can also harbour new chemicals and species of industrial and medicinal importance. As a result, monitoring the structure and functional features of biofilm microbiomes is critical for determining the amount of the risk they represent and harnessing their bioactive potential. Culture-independent metagenomics is one of the most used methods for defining the microbiome. This review article investigates the biofilm microbiome in constructed and natural environments such as agriculture, household appliances, wastewater treatment facilities, hospitals, microplastics, and dental biofilm. We also talked about new findings on the discovery of novel QS and biofilm inhibitors using traditional, metagenomics, and machine learning techniques. Finally, we describe new Metagenome-Assembled Genomes (MAGs) produced from biofilms, as well as genomes and taxa of medicinal and industrial importance. While the biofilm lifestyle has been proven in chronic infections, the prevalence of the biofilm lifestyle in acute infections has recently been questioned in a comparison of chronic and acute lung infections. The majority of bacteria in both chronic and acute illnesses are found in biofilms, according to this study. Interestingly, bacteria organisation in biofilm has been reported in other acute infections, such as necrotizing fasciitis and acute otitis media, as well as in experimental acute wounds and experimental blister wounds.

These findings imply that we require a new bacterial infection paradigm. Because the bacterial growth rate differs between chronic and acute infections, we suggest a new paradigm that focuses on infection characterisation based on bacterial metabolism rather than bacterial aggregation. The activity of inflammatory cells is connected to the formation of biofilm-forming bacteria in persistent lung infections. Surprisingly, bacteria proliferated quicker in sputum from acute infections, despite the fact that inflammatory cells gathered surrounding the biofilms in all infections. This unexpectedly rapid bacterial growth might be due to insufficient maturity of the acquired immune response, when developed, could speed up the inflammatory response seen in chronic lung infections.

Furthermore, virulence factors, including as quorum sensing-mediated inflammatory response inactivation, may be lost during prolonged biofilm infections. Microbiologists have postulated that bacteria live in two growth phases throughout the last 40 years: as single independent cells (planktonic) or as extracellular matrix-embedded clumps called biofilms. Professor Bill Costerton

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and colleagues demonstrated for the first time in 1982 a difference between acute and chronic infection, demonstrating that planktonic bacteria in blood were easily treatable with antibiotics, whereas bacteria in biofilm covering a pacemaker were resistant to the same treatment. Combining this early observation of biofilm-related high antibiotic tolerance with the persistence of *Pseudomonas aeruginosa* microcolonies in the lungs of patients with cystic fibrosis with chronic lung infection spawned the concept of chronic infections being caused by biofilm growing bacteria, while acute infections are caused by planktonic bacteria. This present paradigm was quickly demonstrated by studying bacteria in a shaken, liquid culture developing as planktonic single cells (chains or clusters), whereas bacteria gathered in clumps or linked with surfaces growing as biofilms.

CONCLUSION

However, our understanding of biofilm biology has recently been updated to focus specifically on bacteria in vivo. Biofilms elicit local ongoing pro-inflammatory host responses in chronic lung infections, which are characterised by persistent and progressive disease, whereas biofilm-associated bacteria in the lung are often slow-growing. Furthermore, it has been postulated that many biofilm infections share persistent local inflammation and sluggish microbial growth. If an infection creates clinical signs such as inflammation or fever, it may be eliminated either naturally or by drugs. Such illnesses are referred to as acute infections. A chronic infection occurs when an infection continues despite an immune response and antimicrobial treatment.