A report on biofilm - antibacterial resistance

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PERSPECTIVE

Biofilm is a complex microbiome structure that adheres to the surface and contains different bacterial colonies or single types of cells in a group. These cells, which are embedded in extracellular polymeric substances, a matrix made up primarily of eDNA, proteins, and polysaccharides, demonstrated high antibiotic resistance. It's one of the most common reasons of infection recurrence, especially in nosocomial settings when indwelling devices are used. The regulation of biofilm development relies heavily on quorum sensing. There are a variety of approaches to controlling infections by suppressing their formation, but CRISPR-CAS (gene editing technique) and Photo Dynamic Therapy (PDT) have been proposed as therapeutic approaches to alleviate bacterial biofilm infections, particularly those caused by drug-resistant bad bugs. Bacterial biofilms are a critical worldwide health concern because of their ability to withstand antibiotics, human defense mechanisms, and other external stimuli, contributing to chronic infections that persist. Biofilms are immobile microbial communities that colonize and grow on the surfaces of medical implants such as sutures, catheters, and dental implants, using self-produced extracellular polymeric substances, and cause infections that can only be treated by removing them, resulting in unaffordable treatment and mental illness in patients.

Biofilm development is a multi-step process that includes:

(i) molecule adsorption (both macro and micro molecules)

(ii) bacterial adherence to the surface and release of extracellular polymeric substances (EPS)

(iii) colony formation and biofilm maturation.

When compared to planktonic communities, bacterial biofilm communities metabolic activity has changed, with increased rates of EPS synthesis, activation or inhibition of certain genes related with biofilm formation, and a slower growth rate.

Structure

Microbial biofilm is a collection of sessile microbial communities adhering to a substratum and embedded in a pool of non-crystalline extracellular polymeric matrix created by the microbes themselves. Bacterial biofilm communities differ from planktonic bacterial communities in a variety of ways, including growth rate, gene expression, transcription, and translation, because they live in microenvironments with higher osmolarity, nutrient scarcity, and higher cell density of heterogeneous bacterial communities. The dynamic process of various bacterial populations forming the three-dimensional structure of biofilm is a dynamic process. Bacteria residing in biofilms are protected against a variety of environmental challenges, including as desiccation, antimicrobials, immune system attack, and protozoa ingestion, and as a result of this architecture, biofilm communities progress faster than planktonic communities. Quorum Sensing (QS) is a type of cell-to-cell communication that involves the accumulation of signaling molecules in the extracellular environment, which leads to the regulation of specific gene expression. Biofilm formation is a multi-step procedure. It begins with the bacteria's initial and irreversible adhesion to the substratum, followed by colonization, which involves changes in gene/protein expression, and an exponential growth phase. The production of exopolysaccharides (EPS) and water channels facilitates nutrient supply, which leads to biofilm maturation. Finally, in the surroundings, the cells separate from their surfaces, restarting/recycling biofilm production on new surfaces.

Antibiotic resistance

Biofilm infections, such as those linked with implanted devices, might persist due to reduced antibiotic resistance. Biofilms appear to have different defensive mechanisms than those that cause conventional antibiotic resistance. Poor antibiotic penetration, food restriction and sluggish growth, adaptive stress responses, and the development of persisted cells are thought to form a multi-layered defense in biofilms. Only now are the genetic and molecular aspects of these biofilm defenses beginning to emerge. Each gene and gene product that contributes to resistance might be used to produce novel chemotherapeutic drugs. Disabling biofilm resistance might improve existing antibiotics' capacity to clear illnesses involving biofilms that are resistant to current therapies. Biofilm formation on various biological implants such as heart catheters, urinary catheters, joint implants, and replacement of heart valves leads to treatment complications in a series of human infections, including biofilm formation on various biological implants such as heart catheters, urinary catheters, joint implants, and replacement of heart valves. Because of their persistent nature, biofilms represent a hazard to humans and play a key role in some pathogenic diseases

Gene transfer for antibiotic resistance

The absorption of resistance genes by horizontal gene transfer is one of the antibiotic resistance mechanisms of biofilm ecosystems. High cell density enhanced genetic competence, and accumulation of genetic elements or absorption of resistance genes are all favorable circumstances for horizontal gene transfer in biofilms. Conjugation is the sole way for resistant genes to spread horizontally in biofilms, and it can confirm antibiotic resistance. Few studies have shown that conjugation is more effective in biofilms than in planktonic organisms. One of the implications of bacterial biofilm communities, which contribute to persistent illnesses, is bacterial antibiotic resistance. These biofilm populations have fewer extra resistance mechanisms than planktonic communities, limiting treatment options and leading to the establishment and spread of chronic nasty bugs. Alternative ways to treating infections caused by multidrug resistant, highly drug resistant, and total drug resistance bacteria might include nanoparticle-based antibiotic formulation, new anti-biofilm medicines, CRISPRi gene editing technology, and photodynamic treatment.

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