Journal of Clinical Microbiology and Antimicrobials

OPEN ACCESS Freely available online

Perspective

Role of Biofilm Formation in Chronic Bacterial Infections

Aisha Khan*

Department of Clinical Microbiology and Antimicrobials, Royal Biomedical University, Lahore, Punjab, Pakistan.

ABOVE THE STUDY

Biofilm formation has emerged as a central factor in the persistence and progression of chronic bacterial infections. Unlike free-floating (planktonic) bacteria, biofilm-associated microorganisms exist within structured communities encased in a self-produced Extracellular Polymeric Substance (EPS). This protective matrix, composed of polysaccharides, proteins, and nucleic acids, allows bacteria to adhere to surfaces and survive in hostile environments, including within the human body. The role of biofilms in chronic infections has gained increasing attention due to their contribution to antibiotic resistance, immune evasion, and disease recurrence.

Chronic infections such as those associated with cystic fibrosis, chronic wounds, urinary tract infections, and implanted medical devices are often linked to biofilm-forming bacteria. Common pathogens involved include *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Escherichia coli*. Once a biofilm is established, it becomes highly resistant to antimicrobial agents, often requiring antibiotic concentrations up to 1,000 times higher than those needed to eliminate planktonic cells. This resistance is not solely due to genetic mutations but also results from the physical barrier created by the EPS matrix and the altered metabolic state of bacteria within the biofilm.

One of the defining features of biofilms is their ability to evade the host immune response. The EPS matrix limits the penetration of immune cells and antibodies, while the bacteria within the biofilm can adopt a dormant or slow-growing state that reduces their susceptibility to immune-mediated killing. Additionally, biofilms can modulate host immune responses, leading to chronic inflammation that damages surrounding tissues without effectively clearing the infection. This persistent inflammatory state is a hallmark of many chronic bacterial diseases.

The formation of a biofilm is a dynamic and multi-step process involving initial attachment, microcolony formation, maturation, and eventual dispersion. During the maturation phase, bacteria communicate through quorum sensing a cell-to-cell signaling mechanism that regulates gene expression based on population density. Quorum sensing controls various biofilm-related functions, including EPS production, virulence factor expression, and detachment processes. Disruption of quorum sensing pathways has been explored as a potential therapeutic strategy to prevent or dismantle biofilms.

Biofilms are particularly problematic in healthcare settings due to their association with medical devices such as catheters, prosthetic joints, and heart valves. These surfaces provide an ideal substrate for bacterial attachment and biofilm development. Once established, device-associated biofilms can serve as reservoirs for persistent infections and may require surgical removal of the device for complete resolution. This not only increases patient morbidity but also adds to healthcare costs and resource utilization.

Diagnosing biofilm-associated infections remains challenging, as standard culture techniques may fail to detect bacteria embedded within biofilms. Advanced imaging methods and molecular diagnostics are being developed to improve detection and characterization. However, these technologies are not yet widely available in routine clinical practice, particularly in resource-limited settings.

Treatment of biofilm-related infections requires a multifaceted approach. In addition to conventional antibiotics, strategies such as combination therapy, use of anti-biofilm agents, and physical removal of infected tissues or devices are often necessary. Research into novel therapies, including bacteriophages, antimicrobial peptides, and nanoparticles, is ongoing and holds promise for more effective management of biofilm-associated infections.

In conclusion, biofilm formation plays a critical role in the development and persistence of chronic bacterial infections. Its impact on antimicrobial resistance and immune evasion makes it a significant challenge in clinical practice. A deeper understanding of biofilm biology, along with advancements in diagnostic and therapeutic strategies, is essential to combat these resilient infections and improve patient outcomes.

Correspondence to: Aisha Khan. Department of Clinical Microbiology and Antimicrobials, Royal Biomedical University, Lahore, Punjab, Pakistan. Email: aisha.khan@royalbiomed.edu.pk

Received: 19-May-2025, Manuscript No. JCMA-25-41237; **Editor assigned:** 21-May-2025, PreQC No. JCMA-25-41237 (PQ); **Reviewed:** 04-Jun-2025, QC No. JCMA-25-41237; **Revised:** 11-Jun-2025, Manuscript No. JCMA-25-41237 (R); **Published:** 18-Jun-2025. DOI: 10.35248/JCMA.25.09.228.

Citation: Khan A (2025). Role of Biofilm Formation in Chronic Bacterial Infections. J Clin Microbiol Antimicrob.09:228.