My First Medical Writing

SECTION EDITOR

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Editorial

I am pleased to share an article by an aspiring medical writer from Poland. Hanna Kurlanda-Witek finished her PhD in geoscience at the University of Edinburgh, specialising in microbiology. After working in an environmental consultancy for a few years, she became a freelance science writer, writing about a variety of topics, from radioactivity, to viruses, to plastics. She has now started a career in medical writing, contributing here with an insightful article on biofilms aimed at creating awareness on the infections they may cause. Hope you enjoy this reading.

Evguenia

Gooey and resilient: Biofilms in a clinical setting

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They clog up pipes, coat your teeth, and flourish on benchtops. These communities of microorganisms, known as biofilms, are a cause for concern in the healthcare industry. In Europe, infections caused by biofilms in hospitals alone affect over 4 million patients per year, leading to 37,000 attributable deaths and contributing to an additional 110,000.[1] In the United States, the Centers for Disease Control and Prevention (CDC) estimated that at any given time, 1 in 31 hospital patients has a healthcare-associated infection (HAI).[2] These numbers are not the consequence of a disregard for hygiene by hospital staff, instead they indicate how ubiquitous biofilms are and how difficult it is to eliminate them. Like most bacterial colonies, biofilms thrive on wet surfaces, which is why they are easily found on implants, catheters, and wound dressings. However, biofilms are also perfectly able to survive in dry conditions. One study demonstrated that dry surface biofilms were found on 95% of disinfected items in hospitals.[3] The last two decades have seen extensive research carried out on biofilms, yet they still have the upper hand in hospitals and clinics, and pose a significant medical challenge.

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The perfect community

Biofilms can be described as 3D bacterial communities, often consisting of many types of microorganisms. It is estimated that 99% of bacteria on Earth live in a biofilm.[4] In fact, most of the actual biofilm is made up of exopolysaccharides (EPS), the slimy substance that bacteria secrete. The EPS creates an ideal microbial ecosystem by neutralising harmful conditions, aiding in gene transfer and nutrient exchange, keeping enzymes close to bacteria, and providing a means of intracellular communication known as quorum sensing. As the biofilm matures, pieces of it detach and colonise other areas. Non-attached biofilm aggregates have also been associated with chronic infections, such as cystic fibrosis, a genetic disease characterised by biofilm infections in the lungs.[5]

Biofilms are by no means uniform, accommodating bacteria at different stages of growth and varied metabolic phases. Typically, the bacteria at the outer edges of the biofilm are most active, as they have plenty of accessible oxygen and nutrients. But it is the dormant, slow-growing bacteria in nutrient- and oxygen-depleted zones within the biofilm that are key to its success. Antibiotics and other antimicrobial agents attack the outer layers of the biofilm, leaving the deeper layers intact. Considering how often antibiotics are used in healthcare, the bacteria become increasingly tolerant to ever-rising concentrations. Under laboratory conditions, bacteria in biofilms were demonstrated to be 100 to 1000 times more resistant to antibiotics than "free-living" planktonic bacteria.[6]

The biofilm-fighting toolbox

The tolerance to drugs is a particular threat in treating patients, as increasing dosage of antimicrobials or biocide strength may result in unfavourable side effects. Also, in terms of

medical devices and instruments, the use of strong oxidisers for an extended amount of time is not often possible. The current approach is to use multi-targeted therapies to combat biofilms. Their complex structure results in a no "one size fits all" method of reversing biofilm growth, similar to the modern-day treatment of tumours.[7]

One way of disrupting biofilm structure is to use physical methods, such as high-velocity sprays, which may contain antibiotics or other common biocides. As an at-home example, the use of a dental water jet has proved to be very effective at removing oral plaque biofilm.[8] Coating the surface of medical implants or impregnating wound dressings with, for example, silver nanoparticles, is a method of discouraging biofilm growth before it begins. A similar approach is to re-engineer the surfaces of implants and catheters to make them anti-adherent to bacterial colonisation; changing surface charge, increasing surface roughness by etching nanoscale-structures, or making the surface more hydrophobic are just some ideas for preventing bacteria from sticking to medical devices.[9]

Once a biofilm has grown, the use of EPS-targeting substances is a beneficial technique for breaking up the biofilm. The EPS components can be hydrolysed using enzymes or mechanically disrupted with lasers or ultrasound treatment. Using these methods in combination with antimicrobials is crucial in preventing biofilm regrowth.[7]

Making the leap from basic science

Many solutions for limiting biofilms in health facilities are still at the laboratory stage. The results are convincing, but there are far fewer follow-up experiments in vivo or with the use of human cell models, which is why very little new strategies for combating biofilms advance to clinical trials. Of the clinical trials that are being conducted, most concern oral biofilms, while biofilms in healthcare-associated infections (HAIs) or in chronic diseases are under-represented.[10] Also, despite the amount of research conducted on biofilms (over 40,000 papers as of the end of 2019[10]), many studies still focus on growing bacteria in Petri dishes, or even on analysing planktonic forms of bacteria, instead of focussing on real-life scenarios in the biofilm world. A multidisciplinary approach to biofilm research is essential to fill the void between studies in molecular biology and medicine. Teaming up with start-ups that aim to bring anti-biofilm products to market is also a means of pushing basic science forward and fueling innovation in this field. The "more research is needed" attitude is not enough; it is integrative research on biofilms in healthcare settings that will ultimately decrease the likelihood of infection.

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