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ANTIMICROBIAL CONTACT LENS CASES: PROMISING FUTURE FOR PREVENTING CASE INDUCED OCULAR INFECTION

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ABSTRACT

The use of regular reusable contact lenses significantly raises the risk of ocular infection for people who wear contact lenses. However, this risk can be reduced to a greater extent by the development of antimicrobial contact lens cases. So, in this article, we tried to discuss only about the development of antimicrobial contact lens cases made of different materials and their bright future. In addition, we have taken the opportunity to highlight various ocular diseases, including CLARE and CLPU, both of which are symptoms of wearing contaminated contact lenses.

Keywords: Antimicrobial, Contact Lens Cases, Ocular infection

1. INTRODUCTION

About 175 million people around the world wear contact lenses **[1]**, making them one of the most common and widespread treatments for refractive errors such as myopia, hypermetropia, astigmatism, and presbyopia. Contact lenses can also be used therapeutically to correct colour vision deficiencies such as red-green colour blindness. This is another use for changing one's eye colour. The number of people who wear contact lenses is expected to continue rising in the years to come. This trend is

expected to continue. Most of the persons who wear reusable or daily wear contact lenses put lenses in their eyes every day in morning and remove and store them in lens case overnight. Due to more people using daily disposable contact lenses, the risk of microbial contamination has gone down. This is because the contact lenses and the case don't touch each other.

Due to the formation of biofilm on contact lens cases, occasional wearers of contact lenses run the risk of developing eye infections or inflammation because of microbial contamination of contact lenses and the cases in which they are stored. There is no reduction in the risk of bacterial keratitis in contact lens wearers, even though silicone hydrogel lens materials have reduced the hypoxic changes that occur to the cornea because of overnight wear. The use of a contact lens storage case is required for the overnight storage and disinfection of all types of contact lenses, except for daily disposable and extended wear contact lenses. Daily disposable lenses and extended wear lenses are the only exceptions to this rule. However, it is possible for the contact lens storage case itself to become contaminated with pathogenic microorganisms. Persons who wear contact lenses end up having contaminated storage cases for their lenses in between 35% and 85% of cases **[2]**.

However, the risk of contamination of contact lenses remains the same as lenses are stored overnight with ophthalmic solution filled within the contact lens case. Plastic materials, most commonly polypropylene and polystyrene, are used in the production of contact lens cases, which are sold in the market. These cases have two separate wells that are used to store the ophthalmic solution in which the contact lenses are soaked before use. Despite the variety of solutions that serve multiple purposes including rinsing, cleaning, disinfecting, and storing of contact lenses. The case used for the contact lenses can get a biofilm, which makes it more likely that the case will get dirty and infected with microbes.

According to the results of a number of studies, the contact lens case receives the least amount of attention and it is the item that is most frequently and heavily contaminated when compared to other lens care accessories **[2]**.

2. Contact lens associated Ocular diseases.

The most common causes of CL case contamination include poor hygiene habits by the wearer, inadequate care of CL, and infrequent CL case exchanges. Dirt and other

impurities accumulate both within and outside the CL case, increasing the risk of a biofilm developing inside the CL case. Bacteria that are resistant to disinfectants can be found in CL cases that are not cleaned on a regular basis.

Regular brushing, boiling, and other prescribed procedures are used to combat the problem of ongoing antimicrobial exposure, which involves the challenge of completely eradicating the continuity of the film and killing the bacteria resident in and protected by the film.

As a compromise between expense, convenience, and safety, it is usually best to replace CL cases every three months or more. When it comes to cleaning your contact lenses, current recommendations vary widely, from once every month to every three months (the combined recommendation of the American Academy of Ophthalmology, the Contact Lens Association of Ophthalmologists (CLAO), the Cornea Society, and the American Society of Cataract & Refractive Surgery), and at least every three months (the American Optometry Association). (the Centre for Disease Control & Prevention, USA).

In spite of their many benefits and contrary to what most people think, contact lenses can cause a number of eye infections. One of these is Microbial Keratitis (MK), which includes amoeba keratitis (AK), acanthamoeba keratitis, fungal keratitis (FK), bacterial keratitis (BK), and other inflammatory events like infiltrative keratitis (IK) and contact lens **[3]**.

CLARE affects 34% of lens wearers **[4]**, while CLPU affects 13% of lens wearers. These three conditions are collectively referred to as "common erythrogenic or conjunctival inflammation" (CECI).Although IKs, CLPUs, and CLAREs are quite common, they can often resolve themselves. They don't pose as serious a threat to vision as Bk and FK do, however **[5]**. Acute infections caused by lens contamination, Bk and FK, result in corneal damage and vision loss **[6]**. The fact that the first signs of FK and BK are very similar to the signs of CLPU makes it hard to treat these disorders. As a result, patients are often misdiagnosed and given delayed treatment, which can lead to vision loss. According to numerous studies, BK made for 12-66% of eye diseases brought on by contaminated contact lenses **[7]**. However, only 4% of people who wear contact lenses are affected by FK **[8]**. Both acute ocular infections brought on by contaminated contact lenses—acanthamoeba keratitis and herpes simplex virus keratitis—

have reduced growth rates **[9, 10]**. Acanthamoeba infection causes numerous histological changes, such as necrosis of the common stroma fraction, a lack of keratocytes in the stroma, and corneal ulcers, all of which can lead to visual impairment when present in an acute form **[11]**. More than 25% of contact lens users have reported discomfort while wearing lenses as a result of these problems, and more than 50% have quit using them **[12]**.

In this article, ways for preventing contact lens cases from becoming contaminated, as well as possible solutions are discussed.

3. Microorganisms responsible for contact lens-associated disease

The most common cause of contact lens-related microbial keratitis (up to 91 percent of cases) is *Pseudomonas aeruginosa*. *Coagulase-negative staphylococci*, *Staphylococcus aureus*, and other gram-negative bacteria, such as *Serratia marcescens*, have also been linked to contact lens-related microbial keratitis. *P.aeruginosa, S.marcescens*, and *Haemophilus influenzae* are some of the gram-negative bacteria that can cause non-infectious corneal ulceration **[13]**. Gram-positive bacteria such as *S.aureus* and *Streptococcus pneumoniae* can also cause corneal ulceration.

4. Rationale of Developing Antimicrobial Contact Lens Cases

Microbial and non-infectious keratitis can be prevented by developing new methods of controlling the microbial colonisation of contact lenses. Antimicrobial contact lenses and cases have been developed using a variety of methods.

It is possible to avoid bacterial adherence and colonisation on the surface of contact lenses by using antimicrobial-coated contact lens covers that contain multifunctional solutions, which in turn help to prevent infection and irritation.

In an ongoing endeavour to create antimicrobial contact lens cases, scientists have experimented with a variety of materials. Since silver and selenium have such strong antibacterial properties, they've dominated research into the development of antimicrobial coated contact lens covers thus far. Only silver-infused contact lens cases that kill germs have been given the green light for sale.

5. Antimicrobial contact lens case

There has been a significant amount of work put into the research and development of antimicrobial contact lens cases. But at the moment, the only antibacterial contact lens containers on the market are ones that are filled with silver.

5.1. Silver-impregnated lens cases : Several other approaches to lowering the risk of lens case contamination have been investigated, including the utilisation of silver compounds, which have broad biocidal activity against bacteria and low toxicity to mammalian cells **[14]**. It is well known that silver has the ability to inhibit the growth of bacteria upon contact through interference with DNA, cellular respiration, sulphydryl groups, and enzyme conformation **[15, 16]**, and recent research has shown that silver can be impregnated into lens case materials. The ionic silver that is contained within the silver-impregnated lens case was added during the process of injection moulding, ensuring that it will not be worn away over time **[15]**. There are currently three silver-impregnated cases that are available for purchase on the market: MicroBlock (CIBA Vision, Atlanta, Georgia), I-clean (Sauflon Pharmaceuticals Ltd., London, United Kingdom), and Nano case. [Alcon] (Marietta Vision, Marietta, GA). It is important to keep in mind that several types of silver-impregnated lens cases could have distinctively different modes of operation.

Cases made of Microblock showed strong in vitro activity against most Gram-negative bacteria, but cases made of I-clean were more successful in combating *S. aureus*. In a nutshell, Vermelfoort *et al*. and Dantam *et al*. came to the conclusion that silver-impregnated cases demonstrated effective antibacterial action against *P. aeruginosa* in vitro **[17]**, The clinical trials that were carried out by Dantam *et al*. **[16]** and Amos *et al*. **[14]** showed that silver-impregnated lens cases had a statistically significant lower rate of bacterial contamination than other standard lens cases (the later study showed that the contamination was reduced by approximately 40 percent). Even though these antimicrobial lens cases stop biofilm from forming, it is important to make sure that this doesn't make microorganisms even more dangerous and that toxic parts like silver ions don't have any unintended effects on the eyes or other parts of the body.

Because it is very difficult to get rid of bacterial contamination of lens cases, numerous technologies have been developed to modify the surfaces or materials of lens cases to avoid or reduce the likelihood of bacterial contamination. Several different ways to stop germs from growing have been suggested, such as treating surfaces with either organic or inorganic compounds.

An antimicrobial contact lens case is described by Barry *et al*. This case is made of an antimicrobial polymeric resin and has an antimicrobial surface. A polymeric material

comprising zeolite that has had silver and ammonium ions ion-exchanged thereon is used to make the casing for contact lenses. The container that contains the ophthalmic solution according to the invention does not transfer antimicrobial significant amounts of ions from the polymeric material into the solution **[18]**.

The research conducted by Raheja *et al*. describes a procedure that can be utilised to enhance the antibacterial performance of an ophthalmic solution that is intended for use in the maintenance of contact lenses. The approach makes use of an item that is formed from a plastic resin comprising an aluminosilicate carrier, like Zeolite, which is able to retain antibacterial metal ions. The item is then brought into contact with ophthalmic solution. When the zeolite comes into contact with the case, it releases a rather substantial number of metal ions into the ophthalmic solution, which has the effect of making the solution antibacterial **[18]**.

Dziabo *et al*. developed a contact lens case that incorporates a non-leachable antimicrobial component. This component can either be deposited on the surface of a pre-formed case or it can be copolymerized into the matrix of the case when it is formed. Either way, the non-leachable antimicrobial component is present in the contact lens case. In either scenario, the antimicrobial components do not move between the lens case and the liquid medium it holds, nor do they migrate within the lens case material itself. A region of the lens case's surface that has been abraded will, as a consequence, lack the protection afforded by antimicrobial agents. In addition, the use of halogenated hydrocarbons with antibacterial properties is not specified **[18]**.

Lindley and colleagues developed contact lens cases with antibacterial properties. These cases are made of a polymeric material that has many amorphous zones. A substance that inhibits the growth of microorganisms has been introduced into the amorphous zones of the polymeric material that makes up the body. The antimicrobial agent demonstrates regulated migration while travelling across the amorphous zones of the polymeric substance that makes up said body. The antibacterial ingredient is evenly distributed throughout the surface of the lens housing using this method. The quaternary ammonium salts, phenolic compounds, benzoic esters, and halogenated hydrocarbons are the categories from which the antimicrobial agents are chosen.

5.2. Selenium lens cases

In recent years, research has been focused on selenium's ability to inhibit the growth of

microbes. Inhibiting the formation of *S.aureus* biofilm by selenium that has been covalently integrated into polypropylene polymer contact lens cases has been found to be effective by research. Selenium, which is not currently accessible for purchase in industrial quantities, destroys bacteria by the catalytic generation of superoxide radicals. This process does not require the element to leach out of the material in order for it to be effective. In addition, it is more affordable than silver, and it has a lower propensity to trigger allergic reactions **[19]**. A recent review of antimicrobial contact lenses and cases evaluates aspects of a variety of antimicrobial strategies **[20]**. But more research needs to be done to find out how well silver-impregnated/selenium-included cases work with multipurpose solution and contact lenses, so that the results are more accurate and show the effects of not following the rules.

Farber *et al*. looked at the possibility of using sodium salicylate, which is a nonsteroidal anti-inflammatory medication, in contact lens storage containers in order to inhibit the growth of bacterial biofilms. They employed concentrations of 1 mmol and 3 mmol and discovered a reduction in biofilm formation of 39% and 95%, respectively. These results imply that low doses of this drug may prove useful as a technique of suppressing the formation of biofilm in contact lens storage cases **[21]**.

6. CONCLUSION

The findings of this research indicate that the contamination of contact lens cases is a major cause for worry in terms of public health and may have a substantial role in the development of microbial keratitis in patients who wear contact lenses. Patients should be reminded that they are responsible for the daily cleaning and disinfection of their lens cases, that they should avoid using tap water for rinsing there, that they are required to give careful consideration to where and how the cases are stored while the lenses are being worn, and that they are required to replace their cases on a regular basis.

Antimicrobial agents and surfaces for contact lenses and lens cases are of significant interest to industrial manufactures contact lenses. When one considers the potential advantages of preventing or getting rid of the attachment of infectious organisms to contact lenses and lens cases, it is not surprising that there is such a high level of interest in this topic. So, it's possible that patients would have even fewer bad effects if they were exposed to less infectious organisms. This could mean that more patients would be able to wear contact lenses. Long-term and

continuous use of contact lenses may become more common, which could make the experience of using contact lenses better for a large number of people.

The fact that antimicrobial technology for contact lenses could give an additional level of protection against contamination without requiring the patient's active participation or compliance is an intriguing component of the technology. Additionally, the mechanisms of action of many antimicrobial drugs render the development of bacterial resistance quite improbable. When conducting additional studies, many facets of antimicrobial technology, as applied to contact lenses and lens cases, need to be taken into consideration. There is an immediate need for the development of contact lens cases that make use of natural antibacterial compounds. These compounds should not react with or leach into ophthalmic solutions since this could have a negative impact on the patient's overall ocular health. Further research into the development of antimicrobial cases and best-case practices for case cleaning should be encouraged, and the contact lens industry should provide a new case with each new bottle of solution. There are many antimicrobial technologies that can be researched and used to make wearing contact lenses safer.

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