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Review Article

Bacterial Profile of Ocular Infections: A Mini Review

Karar Ali Abdulkhuder[1*], Abdul Kareem Salman Alyassari[2]

[1,2]Department of Microbiology, Veterinary Medicine College, Al-Qasim Green University, 51013 Babylon, Iraq

***Corresponding Author:** Karar Ali Abdulkhuder
Department of Microbiology, Veterinary Medicine College, Al-Qasim Green University, 51013 Babylon, Iraq

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Abstract: Ocular infections are a growing global health concern, affecting millions worldwide. This review explores the bacterial profile of various ocular infections to aid in developing effective treatments and preventive strategies. The eye's complex anatomy, including the cornea, pupil, iris, lens, and retina, makes it susceptible to infections that can lead to vision loss. Bacteria are a leading cause of these infections, with common culprits including *Escherichia coli*, *Streptococcus*, *Neisseria gonorrhoeae*, and *Staphylococcus aureus*. Environmental factors, allergies, and poor hygiene can exacerbate the risk. Treatment options range from antibiotics and antivirals to eye drops and surgery. Understanding the bacterial profile of ocular infections is crucial for targeted interventions and improved public health outcomes.

Keywords: Ocular Infections, bacterial profile, *Escherichia coli*, *Streptococcus*, *Staphylococcus aureus*.

INTRODUCTION

Ocular infections are among the diseases that have spread widely around the world, and have greatly affected human health first, and then on animals. Many communities are experiencing a significant increase in the incidence of infections with various types of bacteria, especially Gram-positive strains that target ocular structures. These trends pose major health challenges that require investigation and analysis to understand the nature of this phenomenon and its effects (R. A. Astley *et al.*, 2023).

The spread of ocular infections among humans represents a phenomenon linked to environmental and health conditions in different societies. This results in increased demand for scientific research and effective exploration of appropriate treatments. With the rise in infection rates among small animals, there is interest in understanding the similarities and differences in infection patterns between humans and animals, and how these challenges can be effectively addressed (Echevarría-Lucas *et al.*, 2021).

Emphasis should be placed on the complications that such infections can cause in humans and animals. An accurate understanding of the effects of these injuries plays a crucial role in determining treatment and prevention pathways. These complications include potential effects on vision and, in some cases, deterioration of general health, highlighting the importance of continued research in this area (Serwecińska 2020).

It highlights the seriousness of ocular infections and their significant impact on public health. The presence of antibiotic-resistant bacterial strains reinforces the warnings and highlights the importance of taking preventive measures and developing sustainable treatment strategies. It is necessary to anticipate the increase in antibiotic resistance and develop effective methods to address these challenges. Providing a comprehensive overview of these issues in this dissertation will contribute to directing research and efforts toward medical and biological advances that advance our understanding of the effects of Gram-positive ocular infections on human and animal health (Bertino 2009).

Bacteria are a primary reason for eye infections on a global scale. Infections, whether mono or polymicrobial, are linked to different factors such as contact lenses, trauma, surgery, age, dry eye condition, chronic blockage of the nasolacrimal duct, and past eye

infections. Various ocular infections, including conjunctivitis and keratitis, are frequently linked to bacteria, as noted by Godoy-Mancilla *et al.,* (2022). Conjunctivitis is the predominant eye infection, leading to notable economic and social challenges. The illness can impact not just the conjunctiva, but also nearby parts like the eyelid. Chronic conjunctivitis may increase the risk of developing other infections in the eye or surrounding area. Bacteria cause around 50-70% of cases of infectious conjunctivitis. Bacterial conjunctivitis is more frequent in children and the elderly, although it may also be present in newborns and adults (Azari and Arabi 2020). Inflammation of the eyelid, known as blepharitis, may lead to the loss of eyelashes. The infection can spread to other parts of the eye instead of staying in one area. The main reason for corneal blindness is keratitis, the most severe eye infection. Moreover, if not identified early, the illness may advance to endophthalmitis (Petrillo *et al.,* 2022).

The presence of external pathogens, such as bacteria, can result in exogenous endophthalmitis, a type of infection that may develop following cataract surgery, intraocular surgery, or eye injuries. On the other hand, endogenous endophthalmitis typically arises from the systemic dissemination of pathogens. If left undetected in early stages, keratitis and endophthalmitis can result in severe eye infections with serious outcomes (Malmin *et al.,* 2021).

Dacryocystitis is the inflammation of the nasolacrimal duct. In long-term situations, the condition is linked to infection, inflammation of the conjunctiva, fluid buildup, and persistent tearing. Exposure to this could pose a risk to eye structures like the cornea, resulting in endophthalmitis after surgery (Taylor and Ashurst 2023).

If not treated, eye infections can harm the eye's structures, resulting in vision problems and loss of eyesight. Despite the protection of the eye from antibacterial compounds in tears, inflammation and scarring can still happen and may require prompt treatment for resolution. Understanding the particular cause is necessary for successfully managing eye infections. Nevertheless, eye infections are frequently treated based on educated guesses rather than specific knowledge of the bacteria causing them. Hence, the primary aim of this study was to examine the bacterial composition of diverse types of eye infections to furnish specific data for healthcare providers and decision-makers involved in treating ocular infections (Teweldemedhin *et al.,* 2017).

1. Anatomy of the Ocular

The ocular anatomy is a marvel of engineering, a complex and delicate system of structures that work together seamlessly to enable vision. The main components of the eye include:

The cornea is the clear, dome-shaped outer layer of the eye that covers the pupil and iris. It acts as the eye's primary refractive surface, responsible for focusing light onto the retina. The cornea's transparency and precise curvature ensure that light rays are accurately directed, contributing significantly to the overall clarity of vision (Sridhar 2018).

The pupil is the black circular opening in the center of the iris that allows light to enter the eye. It is surrounded by the iris, which controls the size of the pupil through dilation and constriction. The pupil's size regulates the amount of light entering the eye, optimizing vision in varying light conditions (Mathôt 2018).

The iris is the colored part of the eye that surrounds the pupil. It consists of smooth muscles that control the size of the pupil, adjusting it to regulate the light intensity reaching the retina. The iris also plays a crucial role in eye aesthetics, contributing to the unique appearance of each individual (McDougal and Gamlin 2015).

The lens is a transparent, flexible structure located behind the pupil. It is responsible for fine-tuning the focus of light onto the retina by changing its shape through the process of accommodation. The lens enables clear vision at different distances, allowing us to effortlessly switch focus from near to far objects (Glaeser and Paulus 2015).

The aqueous humor is a clear fluid that fills the space between the cornea and the lens. It maintains the shape of the eye, providing the necessary pressure to support the delicate structures within. Additionally, the aqueous humor nourishes the surrounding tissues, supplying oxygen and essential nutrients to the cornea and lens (Sunderland and Sapra 2023).

The vitreous humor is a gel-like substance that fills the space between the lens and the retina. It contributes to the eye's shape, acting as a cushion and protecting the retina from external pressure. The vitreous humor also facilitates the transmission of light to the retina, ensuring optimal visual perception (Zong, Gao, and Hui 2022).

The retina is a thin, light-sensitive tissue that lines the back of the eye. It contains millions of photoreceptor cells (rods and cones) that convert light into electrical signals. These signals are then processed and transmitted to the brain via the optic nerve(Mahabadi and Al Khalili 2023).

Optic nerve it he nerve junction is the part that transmits visual signals from the retina to the brain (Pradeep, Mehra, and Le 2023) as shown in figure 2.1.

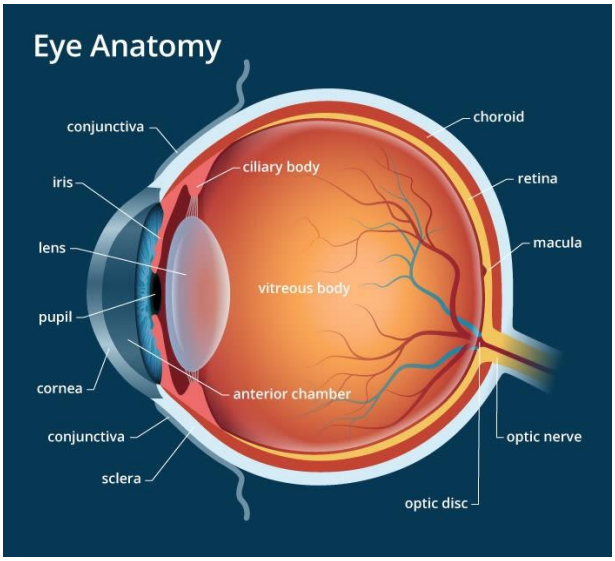

Figure 2.1: Overview of the anatomy and function of the eye (Muchuchuti and Viriri 2023)

2. Bacteria and Ocular infections

Ocular inflammation is a common eye disease that has spread globally, making it a health problem facing many individuals around the world. According to WHO reports, millions of people suffer from ocular infections every year, making it a public health problem that requires public attention and awareness.(Watson, Cabrera-Aguas, and Khoo 2018).

Ocular infections cause a variety of problems and symptoms, some of which can be very serious if left untreated. The eyes are one of the most important organs of the body, playing a crucial role in maintaining our vision and its quality. Ocular inflammation can lead to serious complications such as partial or complete vision loss if timely treatment is not taken(ter Riet, Tellegen, and van Weert 2014).

Ocular infections are mostly caused by infection with bacteria. Among the common bacteria that cause ocular infections, we find Bacteria aeruginosa, Escherichia bacteria, Streptococcus bacteria, and others. In addition to bacteria, environmental factors, allergies, air pollution, and non-compliance with personal hygiene rules play a major role in increasing the likelihood of developing ocular infections.(Ayehubizu, Mulu, and Biadglegne 2021).

In addition to bacteria, other factors can play an important role in increasing the likelihood of ocular infections. Among these environmental factors that must be taken into account is exposure to air pollution. People who live in areas with high air pollution, whether due to industrial or agricultural pollution, are at greater risk of developing ocular infections (Bai *et al.*, 2021).

Methods for treating ocular infections include several options, as treatment depends on the type and severity of ocular inflammation. Treatment includes the use of antibacterial medications in case of bacterial infections, as well as antiviral medications for viral infections. Treatment may also include the use of eye drops and eye ointments to relieve symptoms and soothe ocular infections. In cases of severe ocular infections, surgical treatment may be necessary(Petrillo *et al.*, 2022).

Ocular inflammation is a health condition that can affect different parts of the eye and cause various vision problems. Ocular inflammation can have multiple causes, including bacterial and viral infections, allergies, and rheumatic diseases (Miller and Hanumunthadu 2022). Below are the most prominent of these factors and how they affect eye health.

Bacterial infection is one of the main causes of ocular inflammation. Bacterial ocular infections can develop as a result of harmful bacteria penetrating parts such as the cornea, eyelid, or the surface surrounding the eye. It results in symptoms such as swelling, redness, and albuminous discharge from the eye, and may require treatment with antibiotics(Watson, Cabrera-Aguas, and Khoo 2018).

The most common types of bacteria that cause ocular infections:

2.1. Escherichia coli

Escherichia coli bacteria are usually found in the intestines of humans and animals. It reaches the eyes when swimming water is contaminated or when contaminated cosmetic products are used. Escherichia bacteria are usually considered a harmful strain and may cause serious ocular infections that require immediate treatment. Contamination usually occurs due to non-compliance with personal hygiene rules or the use of contaminated products.(Nunes *et al.*, 2022).

2.2. Streptococcal bacteria (Chlamydia trachomatis)

Streptococcus bacteria are the cause of ocular infections known as trachoma, are common in developing regions and are easily transmitted between people. If left untreated, trachoma can cause permanent vision damage. Bacteria are usually transmitted through direct contact with eyes or using contaminated shared supplies(Hu *et al.*, 2010).

2.3. Neisseria gonorrhoeae

Neisseria bacteria are the main cause of bacterial infections of the eye and are linked to many other diseases. It is easily transmitted through sexual contact or other infections. If untreated, it can cause serious infections and lead to eye damage and vision loss. Bacteria are usually transmitted through direct contact or use of contaminated shared supplies(Quillin and Seifert 2018).

2.4. Staphylococcus aureus

The staphylococcal family Staphylococcaceae includes the genus Staphylococcus, along with other genera like Gemella, Salinicoccus, Jeotgalicoccus, and Macrococcus (Becker, Heilmann, and Peters 2014). The term was created by Alexander Ogston, a Scottish surgeon and bacteriologist, in 1880, like Streptococcus, based on Ancient Greek roots with "Staphylo-" meaning 'bunch of grapes' and the suffix "coccus" meaning 'spherical bacterium' (Kim et al., 2014). Staphylococcus aureus is one of the most common bacteria and is found on the skin, mucous membranes, nose and mouth. It can be transmitted easily when touching eyes with hands or using contaminated tools. *Staphylococcus aureus* bacteria can cause severe ocular infections with symptoms such as redness, swelling, and discharge. The infection usually occurs when the bacteria is transferred to the eyes via contaminated hands or tools.(R. Astley *et al.*, 2019).

A common pathogen of the eye, *S. aureus* can infect both the delicate inner chambers of the anterior and posterior muscles as well as external tissues like the tear duct, conjunctiva, and cornea (Fetsch and Johler 2018). According to (R. Astley *et al.*, 2019), *S. aureus* generates a variety of toxins and enzymes that have the power to seriously harm tissues and organs and alter the immune system's reaction to these infections.

The bacterium *Staphylococcus aureus* is one of the most pathogenic types of staphylococci, despite being part of the normal flora of the skin, nose, pharynx, gastrointestinal tract and genital tract of humans (Nair *et al.*, 2014). It also has the potential to cause opportunistic infections that range from relatively minor skin infections to life-threatening systemic diseases, due to the possession of many surface antigens, enzymes and toxins, these bacteria are able to penetrate the tissues of the body strongly (Riccardi, Rotulo, and Castagnola 2019). The pathogenicity of *S. aureus* is caused by the expression of an arsenal of virulence factors, which can lead to superficial skin lesions, or to more serious infections (Cheung, Bae, and Otto 2021; Afzal *et al.*, 2022).

CONCLUSIONS

Ocular infections pose a significant global health challenge, impacting millions of individuals and animals. This review has highlighted the diverse bacterial profile associated with these infections, emphasizing the roles of *Escherichia coli*, *Streptococcus*, *Neisseria gonorrhoeae*, and *Staphylococcus aureus*. Understanding the specific bacterial etiologies is crucial for developing targeted treatment and prevention strategies.

The eye's intricate anatomy, while enabling vision, also makes it vulnerable to infections that can lead to severe complications, including vision loss and blindness. Environmental factors, allergies, and poor hygiene can further exacerbate the risk of ocular infections. Therefore, a multifaceted approach is essential to combat this growing health concern.

Effective management of ocular infections necessitates a combination of preventive measures, early diagnosis, and appropriate treatment. This includes promoting good hygiene practices, raising awareness about risk factors, and ensuring access to timely and effective antimicrobial therapies. Furthermore, ongoing research is needed to monitor the evolving bacterial landscape and develop novel therapeutic interventions.

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