Advanced Research in Medical and Health Sciences (ARMHS)
Vol. 2, No. 1, 2024
Website: http://journals.jozacpublishers.com/armhs
Received: April 08, 2024 | **Accepted:** April 12, 2024 | **Published:** May 02, 2024
Type of the Paper: ***(Review Article)***

Bacterial conjunctivitis: clinical features, types and complications; a systematic review

Ayesha Haidar[1], Javeria Sharif[2], Ayesha Nadeem[3], Aqsa Perveen[4], Abia Muazzam[5],Areesha Naveed[6], Rameen Atique[7], Hafiza Arshi Saeed[8], Rabbya Rayan Shah[9], Abdul Samad[10]*

[1,2,3,4,6,7,8,9]Department of Pathobiology And Biomedical Sciences, MNS University of Agriculture, 25000, Multan, Pakistan

[5]Department of Biochemistry and Biotechnology, MNS University of Agriculture,25000, Multan, Pakistan

[10]Division of Applied Life Science (BK21 Four), Gyeongsang National University, Jinju 52852, Korea

[1]ayeshahaidar3100@gmail.com, [2]javeriasharif1024@gmail.com, [3]urbashrana7@gmail.com, [4]Perveenaqsa4@gamil.com, [5]abiamuazzam@gmail.com, [6]areesha.naveed237@gmail.com, [7]rameenatiq5@gmail.com, [8]arshisaeed111@gmail.com, [9]rabbiyarayanshah@gmail.com

[10]buzdarabdulsamad@gmail.com

*Corresponding author: buzdarabdulsamad@gmail.com

Abstract

Bacterial conjunctivitis is an eye illness with inflammatory conjunctiva conditions. Neonatorum conjunctivitis was first discovered in 1750 by Quellmaz. In this article, an effective systematic study intends to provide an overview of etiology, prevalence, types with their treatments, diagnosis, and complications that are associated with bacterial conjunctivitis. The researchers have searched PubMed, Google Scholar, and other significant medical journal databases. The systematic review conducted on bacterial conjunctivitis yielded some significant findings and recommendations for future research. The review highlights the significance of comprehending the causes and occurrence of bacterial conjunctivitis. Future studies should prioritize the investigation of developing trends in bacterial strains that cause conjunctivitis, as well as the assessment of variations in prevalence among different populations and geographical regions. The systematic investigation classifies bacterial conjunctivitis into hyper acute, acute, and chronic forms depending on the severity of the symptoms, as well as subtypes such as purulent and mucopurulent conjunctivitis. This review conclude that bacterial conjectivitis can be cured by using antibiotic while extensive use of systemic antibiotics has induced maximal resistance in bacteria that cause ocular infections like conjunctivitis, keratitis, and other related eye illnesses.

Keywords: Acute bacterial conjunctivitis, Antibiotic treatment, Conjunctiva, Etiology, Gonococcal ophthalmic neonatorum

1. Introduction

Bacterial conjunctivitis is the clinical terminology used for the multifactoral inflammation of the thin translucent mucous membrane, conjunctiva, and a glued ocular surface in the morning (Gupta et al., 2024). Eyes are

difficult to open due to purulent or mucopurulent discharge, often yellow-white pus discharge from the eye. It leads to redeye, itching, and stinging (Priyanka, 2022). There is a gritty or foreign body sensation. Conjunctiva can be found inside the eyelid, covering the sclera and lubricating the ophthalmic surface through tear film. The dilation of ocular blood vessels makes the eye look red, and these blood vessels leak fluid, which causes the swelling of tissues (Bilkhu, 2014). Practically, it is a condition that improves on its own but requires treatment for complicated infections like chlamydia conjunctivitis. Bacterial conjunctivitis was treated with herbal strategies in ancient times (Shukla, 2023). Quellmaz first documented ophthalmia neonatorum conjunctivitis in 1750 (Abdulsalam et al., 2015). Crede identified two percent of nitrate solution as medication for conjunctivitis (Mallika et al., 2008). 1883, Koch discovered bacillus, while Weeks observed it as pink eye etiology. Further advancements in treating bacterial infections occurred with antibiotics (Pollock, 1905).

Tetracycline and chloromycetin are frequently used to cure bacterial conjunctivitis. Gram-negative bacterial infections arise in persons using contact lenses (Kumar et al., 2022). A patient's history helps physicians find the current stage of conjunctivitis, whether it is acute or chronic. History, careful ocular examinations, and culture testing help to better diagnose the disease (Azari et al., 2013). When there is visual impairment, redness, discomfort in the eye, or no progress in the patient's condition after taking antibiotics for 24 hours, he or she must consult an ophthalmologist. Physicians often diagnose red-eye infections (Alattas et al., 2019).

Bacterial conjunctivitis affects communities of all ages; about 70% of its outbreaks are cured within eight days. Bacterial conjunctivitis is called pink eye and is prevalent in adults and children (Mahoney et al., 2023). The economic budget for bacterial conjunctivitis was $469 million to $705 million. Bacterial conjunctivitis leads to a pressing illness, keratitis, which occurs about 10/1000 to 30/1000 in people who use corneal lenses (Høvding, 2008). This form of conjunctivitis has maximal prevalence. Gonococcal conjunctivitis appeared at a probability of 0% -10 % in neonates who had been treated with prophylaxis, an antibiotic. Meanwhile, there is a 2%-48% probability of neonates not being treated with prophylaxis. Corneal lens users are more likely to get a gram-negative eye infection (Dart, 1988). Acute bacterial conjunctivitis leads to 1-4% in the Western world and 1% in the United States (Smith & Waycaster, 2009). In 60% or more cases, acute bacterial conjunctivitis heals within the first two weeks. It is estimated that 50-60% of female genital infections caused by chlamydia show no symptoms. Chlamydia shows a maximal prevalence of 5 to 60/100 deliveries.

In children, bacterial conjunctivitis is more likely to occur than viral conjunctivitis. Haemophilus influenza (aerobic bacteria) and S. pneumonia are the most common agents that cause bacterial conjunctivitis in children (Hu et al., 2021). On the other hand, staphylococcus aureus(gram-positive) and Haemophilus influenza(gram-negative) are common causes of adult conjunctivitis (Al-Eryani et al., 2021). Colonization of various microbes is present inside the human body. Ocular conjunctiva contains 3.8%-6.3% of S.aureus, a gram-positive bacteria that causes blepharoconjunctivitis (inflammation related to conjunctiva and eyelid) (Alash, 2015). Furthermore, pathogens like Moraxella catarrhalis, Pseudomonas aeruginosa, Klebsiella pneumonia, Neisseria meningitidis, S. pneumoniae, Neisseria Gonorrhoeae, chlamydia trachomatis, and Staphylococcus epidermidis cause conjunctivitis.

The incubation period of bacterial ocular infection is about 1-7 days, and contagious for 2-7 days. Here, mild to extreme discharge stays all day (Høvding, 2008). Sometimes, viral and acute bacterial conjunctivitis are mistreated because both begin with one eye, and the other eye is affected later (Bielory et al., 2020). To treat bacterial conjunctivitis, one must recognize its differences from viral conjunctivitis. When both eyes are glued in the morning, it represents bacterial conjunctivitis. Viral conjunctivitis shows red, itchy eyes and watery discharge with an incubation period of 5-12 days and is contagious for 10-14 days (Baware et al., 2023). Among all acute conjunctivitis, viral conjunctivitis appears at 80%, and bacterial conjunctivitis at 50-75% among young children. Viral diagnosis should be performed by PCR, viral culture scrapping, and adenovirus antigen. Viral

conjunctivitis has two dominant forms: pharyngoconjunctival fever and epidemic keratoconjunctivitis (EKC), resulting from Adenovirus serotypes 3,4,7 and 8, 19,37 respectively (Jonas et al., 2020). Bacterial conjunctivitis releases thick purulent to mucopurulent and arises mainly from December to April (winter), while there is watery release in the outbreak of viral conjunctivitis. Viral conjunctivitis has a peak prevalence during summer (Das & Basu., 2020).

Staphylococcus species like staphylococcus aureus and staphylococcus pneumonia have developed alarming resistance against antibiotics. Azithromycin and tetracycline long-term or misuse induce resistance in bacterial species like Staphylococcus aureus. Methicillin-resistant and Vancomycin-resistant species are present nowadays, like MRSA methicillin-resistant Staphylococcus aureus and VRSA vancomycin-resistant Staphylococcus aureus (Gajdács, 2019). Trimethoprim and aminoglycosides are more potent against methicillin-resistant staphylococci (MRSA) than sulfonamides. Besifloxacin shows maximal activity in vitro against MRSA and has potential against topoisomerases II and IV (Mah & Sanfilippo, 2016). Unfortunately, not every class of antibiotics is effective against all types of bacterial infections. So, a physician must prescribe an antibiotic that is effective against nearly the whole range of that bacterial species or gives excellent coverage. Bacterial conjunctivitis is commonly treated by topical antibiotics such as eye drops or ocular ointment. The antibiotic form is prescribed based on the severity of the disease (Karpecki et al., 2010).

Gonococcal ophthalmia neonatorum or chlamydial conjunctivitis (type of bacterial conjunctivitis) is treated by systemic antibiotics. Antibiotics for ubiquitous bacteria include ciprofloxacin, rifampin, ofloxacin, neomycin, erythromycin, and gatifloxacin. These antibiotics reduce bacterial conjunctivitis's severity, complications, and period (Cervantes & Mah, 2011). Furthermore, moxifloxacin suspension is also effective in treating bacterial infections. Once the patient completely recovers, the researchers should discontinue the medication. However, if the patient's eye condition worsens, he should consult an ophthalmologist. It is essential not to use corticosteroids during these infections because corticosteroids suppress the immune response, leading to prolonged infection.

Numerous microbes exist inside the human body, and diverse microbial species like Corynebacteria, streptococci, and staphylococci colonize the human eyelid. Normal flora does not cause any infection, but when there is contamination by microbes, infection occurs (Ranjith et al., 2021). Dry eyes due to eyelid issues make the ocular surface contagious to bacterial infections—the higher the severity, the longer the recovery period. Eye-hand contact spreads bacterial conjunctivitis and is highly contagious (Alajbegovic-Halimic et al., 2023). If a person uses contact lenses, it is advisable to use a fresh and neat pair of lenses because various bacteria reside on them. The researchers can limit the virulence and widespread disease severity by washing hands frequently, taking good care of lid hygiene, removing discharge using tissue paper rather than direct contact with hands, and disinfecting the used items with any antibiotic wipes and pillowcases should also be cleaned up.

2. Clinical severity (major types)

Bacterial conjunctivitis has three types based on clinical severity: hyperacute, acute, and chronic bacterial conjunctivitis (Hashmi et al., 2024). In hyperacute bacterial conjunctivitis, continuous purulent discharge occurs in gonococcal conjunctivitis or neonatal conjunctivitis. Gonococcal ophthalmia neonatorum breakout in the neonates 3-21 days after delivery. It happens when newborn conjunctiva is exposed to the potion of vaginal, cervical, and uterine mucus (VCM) of infection mother (Luo et al., 2024). Neonatal conjunctivitis typically occurs due to *staphylococcus aureus* and *Haemophilus influenza.* Adult gonococcal conjunctivitis AGC has been a rare disease in recent years, and a person infected with AGC is treated in the ICU. Azithromycin can be the most suited antibiotic for this treatment. Physicians also use aminoglycoside eye drops to cure and reduce

the severity of infection. Quinolone is not used nowadays because bacteria have developed resistance against it. Hyperacute conjunctivitis mainly causes inflammation in one eye, but it is not valid in every outbreak. Usually, gram staining is done to check for hyperacute bacterial conjunctivitis. When such an illness is left untreated, it can cause complications like corneal ulcers and eyeball perforation, Neisseria meningitis, and *Neisseria gonorrhea* (diplococcus, gram-negative bacteria).

Acute bacterial conjunctivitis includes red eyes connected with foreign body sensations without enough ocular pain. The burning sensation is one of the symptoms (Bhat & Jhanji, 2021). This disease condition remains for less than three to four weeks. Here, vasodilation in the conjunctiva membrane becomes maximal, causing arterial hyperemia. There is a discharge of pus or mucous from the ocular surface. Human eye vision is not affected in acute conjunctivitis unless there is the maximal discharge of purulent or mucopurulent. When corneal epithelial deforms occur, there is a chance of inflammation of the cornea, medically known as iridocyclitis or keratitis. Risk factors include *staphylococcus pneumonia* and *staphylococcus* in children, whereas pathogens like *staphylococcus epidermis, staphylococcus aureus,* and *E.coli* in adults. Topical antibiotic treatment is performed in mild acute bacterial conjunctivitis, which is also cost-effective for infected patients (Sahoo et al., 2011).

Chronic bacterial conjunctivitis is related to purulent (Latin word meaning pus) discharge with redness (Adya & Inamadar., (2015). The pus secretion is mild, and there is eyelash loss, itching, and burning. There is also inflammation of the meibomian gland in the eye region. Chronic conjunctivitis stays predominantly longer than four weeks. The causative agents for this ocular infection are *Chlamydia trachomatis, Moraxella lacunata, and staphylococci* species. Toxins are produced by *Staphylococcus* (primary etiology for chronic bacterial conjunctivitis), which causes margins and epithelial keratitis. Eyelids become red and swollen; this condition is termed blepharitis. Tetracycline and metronidazole are effective during chronic conjunctivitis (SMILACK et al.,1991; Khadamy, 2024).

3. Discharge formation

The discharge or sticky fluid in bacterial conjunctivitis is in the form of membranous, purulent, and mucopurulent; hence named membraneous conjunctivitis (rare nowadays), purulent conjunctivitis, and mucopurulent conjunctivitis respectively (Hashmi et al., 2024). Let us discuss all these categories one by one. Firstly, membranous bacterial conjunctivitis is acute, intense inflammation of the conjunctiva membrane with the deposition of fibrous, which in return forms another membrane on the ocular conjunctiva (Ahmed, 1993). When membranous conjunctivitis is in its severe form, peeling off the fibrous membrane is risky. The ocular conjunctiva is formed of an epithelium and stroma. The epithelium layer breaks and leads toward bleeding. This occurs in the case of the diphtheric membrane. The other type is the non-diphtheritic membrane, where the epithelium layer of the conjunctiva is not torn while exudes are removed. Clinical examinations and staining are done to diagnose membraneous conjunctivitis. If a patient suffering from membranous conjunctivitis is not cured and does not consult an ophthalmologist, it can decrease vision and corneal ulceration. Topical and systemic antibiotics are given to patients suffering from this kind of conjunctivitis. Anti-diphtheric serum of 4-10000 units is also effective in medication (Weeks, 1910).

The next type is purulent conjunctivitis, also known as gonococcal conjunctivitis. Here is thick yellow to green purulent discharge and profuse discharge. It causes the hyperacute form of conjunctivitis. Primary etiology includes *Neisseria gonorrhoeae* (typical source for genital infections in adults). It occurs in infants or neonates during birth from an infected mother's cervicovaginal exude, or briefly, we can say, from the birth canal. In purulent conjunctivitis, the cornea is abnormally inflamed and complicated to diagnose. If gonococcal ophthalmia conjunctivitis is not treated, it leads to corneal perforation and ulceration (Azari & Barney, 2013).

The conjunctiva gives a dark red appearance, which can be seen as velvety. Pain, warmth, periocular edema, enlargement of the lymph node that drains the lateral portion of the conjunctiva, purulent discharge, and dilation of conjunctival vessels are included as signs of purulent conjunctivitis (LeHoang, 2006). It is diagnosed at the clinic and through laboratory tests such as gram staining. Ceftriaxone and azithromycin are given to adults as antimicrobial treatments that reduce disease incidence. In the case of neonatal conjunctivitis, prophylaxis antibiotics are given postpartum (a medical term indicating birth time). Neonatal conjunctivitis is caused by *Haemophilus influenza* and *staphylococcus aureus* (Honkila et al., 2018).

Chlamydia trachomatis (a gram-negative bacteria) is a less common etiology of bacterial conjunctivitis. Other than adults, it also infects infants when the mother has a cervical chlamydial illness. Almost 50% of infants acquire a condition called chlamydial pneumonitis in one to three months. Chlamydial pneumonitis is an acute infection. Chlamydia conjunctivitis is also a sexually transmitted disease. Here, purulent discharge is prominent. Topical (ointments or eyedrops) and systemic (capsules or injection) antibiotics are satisfactory for curing purulent conjunctivitis (Devipriya, 2020). But haphazard use of Antibiotics can cause antibiotic resistance as well (Ahmad et al., 2023; Atique et al., 2023; Atique et al., 2024; Hamza et al., 2023; Samad, 2022; Samad et al., 2022; Talib et al., 2024; Tariq et al., 2022).

The last type based on exude formation or discharge from conjunctiva is mucopurulent conjunctivitis. Muco means mucus, and purulent means pus. This type is the highly prevalent type of acute bacterial conjunctivitis. The conjunctiva has three portions: the bulbar, fornix, and palpebral part (Seregard et al., 2014). In mucopurulent conjunctivitis, the fornix and palpebral portions seem to have maximal red color. Mucopurulent can be seen at the margins of eyelids. Ocular vision is not affected. It is clinically diagnosed. Its antimicrobial treatment includes topical eye drops like gentamycin and ointments like polyfax and ciprofloxacin, taken at night (Mazumder, 2017). Most cases are cured on their own (self-limiting situation).

4. Study methodology

This review methodically gathered data on bacterial conjunctivitis from credible internet sources, primarily focusing on utilizing Google Scholar and PubMed (Sommer & Blumenthal, 2020). These platforms were selected based on their comprehensive coverage of scholarly publications in medicine and public health. Google Scholar is a comprehensive search engine that allows users to search for academic papers, theses, books, and conference proceedings in various fields of study (Gusenbaue & Haddawa, 2020). Relevant material was retrieved using keywords linked to bacterial conjunctivitis, watery eye, and clinical presentation.

Methodology for conducting a search

The researchers performed methodical searches utilizing suitable search terms, guaranteeing the inclusion of up-to-date and relevant papers about bacterial conjunctivitis.

Data filtration and arrangement

The search results were refined using relevance and publication date criteria to prioritize recent research findings and intellectual contributions.

PubMed

PubMed is a dedicated search engine that grants access to an extensive collection of articles and abstracts from biomedical journals and life science publications (AlRyalat et al., 2019).

Evaluation

Every source obtained was thoroughly assessed for its methodological rigor, pertinence to the study topics, and credibility of the authors. The researchers conducted a thorough and accurate data collection for this review study on bacterial conjunctivitis using systematic search tactics and the extensive databases of Google Scholar and PubMed.

5. Results

The systematic review of bacterial conjunctivitis yielded some significant findings and recommendations for future research. The review highlights the significance of comprehending the causes and occurrence of bacterial conjunctivitis. Future studies should prioritize investigating developing trends in bacterial strains that cause conjunctivitis, as well as assessing variations in prevalence among different populations and geographical regions. The systematic investigation classifies bacterial conjunctivitis into hyperacute, acute, and chronic forms depending on the severity of the symptoms, as well as subtypes such as purulent and mucopurulent conjunctivitis. Further investigation should focus on enhancing treatment techniques for each subtype, such as investigating innovative antibiotic formulations, combination medicines, and alternative therapy methods. The study emphasizes the significance of precise diagnosis and effective treatment of bacterial conjunctivitis to avoid complications such as keratitis and corneal ulceration. Future research endeavors could prioritize the development of expeditious diagnostic assays for bacterial conjunctivitis, exploring innovative therapeutic strategies to alleviate problems and enhance patient outcomes. The review examines the rise of bacterial strains that are resistant to antibiotics, emphasizing the importance of using antibiotics wisely and monitoring resistance patterns. Potential future investigations may focus on tactics to address antibiotic resistance in bacterial conjunctivitis, such as creating novel antimicrobial substances, implementing antimicrobial stewardship initiatives, and the enforcement of infection control protocols. The analysis highlights the significance of public health actions, such as practicing hand cleanliness, maintaining lid hygiene, and disinfecting shared items, to effectively prevent bacterial conjunctivitis transmission. Subsequent studies could assess the efficacy of these strategies in decreasing the occurrence and spread of bacterial conjunctivitis among populations. Exploring the clinical severity of bacterial conjunctivitis and its connection to consequences like corneal ulceration could offer a valuable understanding of how the disease develops and its prognosis. Conducting longitudinal studies to monitor patients with bacterial conjunctivitis could assist in identifying characteristics that increase the likelihood of catastrophic outcomes and provide valuable insights for developing clinical care strategies.

Pediatric considerations

Due to the increased occurrence of bacterial conjunctivitis in children, it would be beneficial for future research to concentrate on specific elements of the disease relevant to pediatric patients. This might include determining the most effective treatment regimens, understanding the influence of the disease on visual development, and investigating any long-term consequences. Moreover, researching the efficacy of vaccines in preventing bacterial conjunctivitis in children could be advantageous.

6. Conclusion

This review concludes that bacterial conjunctivitis can be cured using antibiotics. In contrast, extensive use of systemic antibiotics has induced maximal resistance in bacteria that cause ocular infections like conjunctivitis, keratitis, and other related eye illnesses. Future strategies and antibiotics should be formulated that have high potency, high effectiveness, and reduced capability to induce resistance in gram-positive and gram-negative

bacteria. *Staphylococcus aureus* makes up almost 3.8-6.3% of the eye. Conjunctivitis results from the contamination of the eye's normal flora. Acute Bacterial conjunctivitis has a higher prevalence rate than any other bacterial conjunctivitis type. In the laboratory, gram staining is done to test whether the swabs of ocular culture are positive bacterial cultures. In clinics, physicians prescribe mostly topical antibiotics for bacterial eye infections, i.e., bacterial conjunctivitis. Hyperacute conjunctivitis develops thick, creamy, purulent discharge, while acute conjunctivitis secretes mucopurulent or purulent discharge. Chronic bacterial conjunctivitis secretes average purulent discharge with highly swollen conjunctiva, leading to another eye condition called blepharitis. There is a rare condition where a fibrous layer forms over the conjunctiva, creating a diphtheria (actual) or non-diphtheric (pseudo) membrane. During the postpartum, when gonococcal is infected, the mother's cervicovaginal fluid comes into contact with the infant's eye, causing gonococcal ophthalmia neonatorum. Cervicovaginal fluid is a genital secretion. In adults, gonococcal infections occur through genitalia (a sexually transmitted disease), and patients infected with adult gonococcal conjunctivitis AGC are frequently treated with aminoglycoside drops due to quinolone resistance. Significant symptoms include congestion, mucoid or purulent secretion of the conjunctiva, edema, and sticky clammy eyelids.

References

1. Abdulsalam, M., Ibrahim, M., & Asani, M. O. (2015). An overview of neonatal conjunctivitis. *Sudan Medical Monitor*, *10*(3), 91.
2. Adya, K. A., & Inamadar, A. C. (2015). Gram-negative bacterial infections. *Comprehensive Approach to Infections in Dermatology*, 52-82.
3. Ahmad, B., Samad, A., & Hamza, M. (2023). Antibiotic Resistance in Poultry and Farm Animals and its Solution. *Biological Times*, *2*(3), 3-4.
4. Ahmed, E. (1993). *A textbook of ophthalmology*. Oxford University Press.
5. Alajbegovic-Halimic, J., Jovanovic, N., & Halimic, T. (2023). Microbiological evaluation of bacterial conjunctivitis in children. *Acta Medica Saliniana*, *53*(1).
6. Alash, S. A. (2015). Study the prevalence of bacterial conjunctivitis in Iraq. *Iraqi journal of science*, *56*(4C), 3371-5.
7. Alattas, O. A., Hamdi, A. A., Mudarba, F. M. M., Alshehri, A. M., Al-Yahya, M. S., Almotairi, S. A., ... & Alamri, I. A. (2019). Red Eye Diagnosis and Management in Primary Health Care. *Archives of Pharmacy Practice*, *10*(3).
8. Al-Eryani, S. A., Alshamahi, E. Y. A., Al-Shamahy, H. A., Alfalahi, G. H. A., & Al-Rafiq, A. A. (2021). Bacterial conjunctivitis of adults: causes and ophthalmic antibiotic resistance patterns for the common bacterial isolates. *Universal Journal of Pharmaceutical Research*, *6*(1), 25-28.
9. AlRyalat, S. A. S., Malkawi, L. W., & Momani, S. M. (2019). Comparing bibliometric analysis using PubMed, Scopus, and Web of Science databases. *JoVE (Journal of Visualized Experiments)*, (152), e58494.
10. Atique, R., Saeed, H. A., Anwar, B., Perveen, A., Sharif, J., Haidar, A., ... & Samad, A. (2023). Quorum Sensing in Bacteria; Cell-to-cell Communication and Signaling Mechanism. *International Journal of Social, Humanities and Life Sciences*, *1*(1).
11. Atique, R., Saeed, H. A., Anwar, B., Rana, T., Haidar, A., Muazzam, A., ... & Samad, A. (2024). Brief overview on Bacteriophage therapy; Alternative to Antibiotics. *arXiv preprint arXiv:2402.10245*.
12. Azari, A. A., & Barney, N. P. (2013). Conjunctivitis: a systematic review of diagnosis and treatment. *Jama*, *310*(16), 1721-1730.
13. Baware, A. S., Vir, D. K., & Sanap, G. (2023). Eye conjuctivitis. *International Journal of Pharmaceutical Sciences*, *1*(12), 1-1.

14. Bhat, A., & Jhanji, V. (2021). Bacterial conjunctivitis. *Infections of the Cornea and Conjunctiva*, 1-16.

15. Bielory, L., Delgado, L., Katelaris, C. H., Leonardi, A., Rosario, N., & Vichyanoud, P. (2020). ICON: diagnosis and management of allergic conjunctivitis. *Annals of Allergy, Asthma & Immunology*, *124*(2), 118-134.

16. Bilkhu, P. (2014). *Management of allergic conjunctivitis and dry eye* (Doctoral dissertation, Aston University).

17. Cervantes, L. J., & Mah, F. S. (2011). Clinical use of gatifloxacin ophthalmic solution for treatment of bacterial conjunctivitis. *Clinical Ophthalmology*, 495-502.

18. Dart, J. K. (1988). Predisposing factors in microbial keratitis: the significance of contact lens wear. *British Journal of Ophthalmology*, *72*(12), 926-930.

19. Das, A. V., & Basu, S. (2020). Epidemic keratoconjunctivitis in India: trend analysis and implications for viral outbreaks. *Indian journal of ophthalmology*, *68*(5), 732-736.

20. Devipriya, C. K. (2020). *A Randomized Controlled Trial to Assess the Efficacy of Topical Besifloxacin 0.6% Versus Moxifloxacin 0.5% in Bacterial Conjunctivitis* (Doctoral dissertation, Chengalpattu Medical College and Hospital, Chengalpattu).

21. Gajdács, M. (2019). The continuing threat of methicillin-resistant Staphylococcus aureus. *Antibiotics*, *8*(2), 52.

22. Gupta, A., Bansal, R., Sharma, A., & Kapil, A. (2024). Red Eyes—Conjunctivitis, Corneal Ulcers, Dry Eye Disease, and Acute Uveitis. In *Ophthalmic Signs in Practice of Medicine* (pp. 493-542). Singapore: Springer Nature Singapore.

23. Gusenbauer, M., & Haddaway, N. R. (2020). Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. *Research synthesis methods*, *11*(2), 181-217.

24. Hamza, M., Khera, H. U. R. A., Waqas, M. U., Muazzam, A., Tariq, S., Kaleem, Z., ... & Samad, A. (2023). Misuse of Antibiotics in Poultry Threatens Pakistan Communitys Health. *arXiv preprint arXiv:2311.07168*.

25. Hashmi, M. F., Gurnani, B., Benson, S., & Price, K. L. (2024). Conjunctivitis (nursing). In *StatPearls [Internet]*. StatPearls Publishing.

26. Hashmi, M. F., Gurnani, B., Benson, S., & Price, K. L. (2024). Conjunctivitis (nursing). In *StatPearls [Internet]*. StatPearls Publishing.

27. Honkila, M., Renko, M., Ikäheimo, I., Pokka, T., Uhari, M., & Tapiainen, T. (2018). Aetiology of neonatal conjunctivitis evaluated in a population-based setting. *Acta Paediatrica*, *107*(5), 774-779.

28. Høvding, G. (2008). Acute bacterial conjunctivitis. *Acta ophthalmologica*, *86*(1), 5-17.

29. Hu, Y. L., Lee, P. I., Hsueh, P. R., Lu, C. Y., Chang, L. Y., Huang, L. M., ... & Chen, J. M. (2021). Predominant role of Haemophilus influenzae in the association of conjunctivitis, acute otitis media and acute bacterial paranasal sinusitis in children. *Scientific Reports*, *11*(1), 11.

30. Jonas, R. A., Ung, L., Rajaiya, J., & Chodosh, J. (2020). Mystery eye: Human adenovirus and the enigma of epidemic keratoconjunctivitis. *Progress in retinal and eye research*, *76*, 100826.

31. Karpecki, P., Paterno, M. R., & Comstock, T. L. (2010). Limitations of current antibiotics for the treatment of bacterial conjunctivitis. *Optometry and Vision Science*, *87*(11), 908-919.

32. Khadamy, J. (2024). Ocular Rosacea: Don't Forget Eyelids and Skin in the Assessment of This Stubborn Ocular Surface Disease. *Cureus*, *16*(1).

33. Kumar, N. M., & Mah, F. S. (2022). Bacterial, Chlamydial, and Mycobacterial Infections. *Albert and Jakobiec's Principles and Practice of Ophthalmology*, 281-307.

34. LeHoang, P. (2006). *Blepharitis and conjunctivitis: Guidelines for diagnosis and treatment*. Editorial Glosa, SL.

35. Luo, Y., Gu, C., Sun, Y., Guo, J., Lai, W., Deng, W., ... & Luo, M. (2024). Pathogenic and clinical features of neonatal bacterial conjunctivitis in southern China: a retrospective study.

36. Mah, F. S., & Sanfilippo, C. M. (2016). Besifloxacin: efficacy and safety in treatment and prevention of ocular bacterial infections. *Ophthalmology and therapy*, *5*, 1-20.

37. Mahoney, M. J., Bekibele, R., Notermann, S. L., Reuter, T. G., & Borman-Shoap, E. C. (2023). Pediatric conjunctivitis: a review of clinical manifestations, diagnosis, and management. *Children*, *10*(5), 808.

38. Mallika, P. S., Asok, T., Faisal, H. A., Aziz, S., Tan, A. K., & Intan, G. (2008). Neonatal conjunctivitis–a review. *Malaysian family physician: the official journal of the Academy of Family Physicians of Malaysia*, *3*(2), 77.

39. Mazumder, P. (2017). *Impact of sunlight on chloramphenicol mediated synthetic and herbal eye drops in terms of antimicrobial activity* (Doctoral dissertation, BRAC University).

40. Pollock, W. I. (1905). *A Bacteriological and Clinical Study of Conjunctivitis* (Doctoral dissertation, University of Glasgow (United Kingdom)).

41. Priyanka, S. (2022). *Categorisation of Ophthalmic Conditions of Siddha Literature through Current Ophthalmic Practice: A Cross Sectional study* (Doctoral dissertation, National Institute of Siddha, Chennai).

42. Ranjith, K., Sharma, S., & Shivaji, S. (2021). Microbes of the human eye: Microbiome, antimicrobial resistance and biofilm formation. *Experimental Eye Research*, *205*, 108476.

43. Sahoo, S., Haq, A., Sahoo, R., & Sahoo, I. (2011). Management of Conjunctivitis in General Practice. In *Conjunctivitis-A Complex and Multifaceted Disorder*. IntechOpen.

44. Samad, A. (2022). Antibiotics resistance in poultry and its solution. *Devotion: Journal of Research and Community Service*, *3*(10), 999-1020.

45. Samad, A., Hamza, M., Muazzam, A., Ahmer, A., Tariq, S., Shahid, M. J., ... & Din, F. U. (2022). Overview of Bacterial Diseases in Poultry and policies to control disease and antibiotic resistance. *BULLET: Jurnal Multidisiplin Ilmu*, *1*(01), 19-25.

46. Seregard, S., Blasi, M. A., & Balestrazzi, E. (2014). Conjunctiva. In *Eye Pathology: An Illustrated Guide* (pp. 41-77). Berlin, Heidelberg: Springer Berlin Heidelberg.

47. Shukla, A. K., Yadav, V. K., Yadav, V. P., Tiwari, A., Tiwari, P., Verma, G., ... & Sharma, M. (2023). An overview of the herbs used to treat conjunctivitis. *Current Advances in Biosciences*, 207.

48. Smilack, J. D., Wilson, W. R., & Cockerill, III, F. R. (1991, December). Tetracyclines, chloramphenicol, erythromycin, clindamycin, and metronidazole. In *Mayo Clinic Proceedings*, 66(12), 1270-1280. Elsevier.

49. Smith, A. F., & Waycaster, C. (2009). Estimate of the direct and indirect annual cost of bacterial conjunctivitis in the United States. *BMC ophthalmology*, *9*, 1-11.

50. Sommer, A. C., & Blumenthal, E. Z. (2020). Telemedicine in ophthalmology in view of the emerging COVID-19 outbreak. *Graefe's Archive for Clinical and Experimental Ophthalmology*, *258*, 2341-2352.

51. Talib, A., Samad, A., Hossain, M. J., Muazzam, A., Anwar, B., Atique, R., ... & Joo, S. T. (2024). Modern Trends and Techniques for Food Preservation. *Food and Life*.

52. Tariq, S., Samad, A., Hamza, M., Ahmer, A., Muazzam, A., Ahmad, S., & Amhabj, A. M. A. (2022). Salmonella in poultry; an overview. *International Journal of Multidisciplinary Sciences and Arts*, *1*(1), 80-84.

53. Weeks, J. E. (1910). Vaccine and serum therapy in ophthalmology. *Transactions of the American Ophthalmological Society*, *12*(Pt 2), 598.