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Original Research Article

Evaluation of Antimicrobial Resistance Patterns in Bacterial Conjunctivitis

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Abstract:

Background: "Bacterial conjunctivitis is a common ocular infection with rising concerns regarding antibiotic resistance among causative pathogens.

Aim: To determine the bacterial profile and antibiotic resistance patterns in patients with bacterial conjunctivitis.

Methodology: A hospital-based cross-sectional study was conducted in the Department of Ophthalmology, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India, over seven months. Ninety adult patients with clinically suspected bacterial conjunctivitis were enrolled. Conjunctival swabs were cultured, organisms identified, and antibiotic susceptibility testing performed using disc diffusion according to BSAC guidelines.

Results: Females (57.8%) and elderly patients (>70 years, 17.8%) were more commonly affected. Purulent discharge (91.1%) and conjunctival hyperemia (84.4%) were predominant symptoms. Gram-positive bacteria predominated, with *Staphylococcus aureus* (33.3%) and *Streptococcus pneumoniae* (22.2%) most frequent. Among Gram-negative isolates, *Pseudomonas aeruginosa* (13.3%) was common. Ciprofloxacin and gentamicin showed low resistance rates, whereas chloramphenicol exhibited comparatively higher resistance across isolates.

Conclusion: Gram-positive organisms were predominant, and fluoroquinolones remain effective empirical therapy. Continuous surveillance and rational antibiotic use are essential to limit emerging resistance.

Keywords: Bacterial conjunctivitis, Antibiotic resistance, *Staphylococcus aureus*, Ciprofloxacin", Chloramphenicol.

Introduction

One of "the most prevalent ocular infections that are experienced in clinical practice is bacterial conjunctivitis which is inflammation of a conjunctival tissue accompanied by redness, discharge and discomfort [1]. It can hit people of all ages, but some groups of people are more susceptible to the disease, including children and immunocompromised patients. A wide range of pathogens are etiologically responsible of causing bacterial conjunctivitis, the most common of which are Staphylococcus aureus, Streptococcus pneumoniae, Haemophilus influenzae, and Pseudomonas aeruginosa [2]. They can be passed on through direct contact, contaminated hands, or on fomites, and personal hygiene and environmental hygiene are equally important in the prevention of diseases. Although bacterial conjunctivitis may be self-limiting in most cases, early diagnosis and the use of the right antimicrobial agent is very crucial to avoid complications, including keratitis, corneal ulceration, or, in the rare cases, loss of sight.

In the past, the treatment of bacterial conjunctivitis depended on topical antibiotics, such as fluoroquinolones, aminoglycosides, and macrolides, which were very effective against the most common pathogens [3]. Nevertheless, the past few decades also have witnessed an alarming trend of antibiotic resistance in ocular isolates of bacteria, making treatment regimens more difficult and presupposing chances of treatment failure. Antimicrobial resistance of ocular pathogens is an international phenomenon that is similar to systemic infections, where the extensive and often indiscriminate administration of antibiotics is applied in human and veterinary practice. Poor use of the broad-spectrum antibiotics, insufficient courses of treatment, and the possibility of topical agents purchased directly at pharmacies are also the main sources of the selection pressure that promotes the development of resistant strains [4]. Moreover, horizontal gene transfer between bacterial populations helps to spread the determinants of resistance easily, which only aggravates the problem of efficient treatment of ocular infections.

The problem of antibiotic resistance in bacterial conjunctivitis is especially noteworthy because it could affect the overall health of people and the treatment process [5]. There have been growing reports of resistant strains of Staphylococcus aureus and methicillin-resistant S. aureus (MRSA) in ocular infections around the world and possessing reduced susceptibility to a variety of antibiotic classes. Equally, Streptococcus pneumoniae and Haemophilus influenzae strains have been shown to be resistant to frequently used macrolides as well as penicillin derivatives [6]. These resistance patterns in addition to extending the length of illness also raise the chances of spread especially in the community like in schools and daycare centers. Moreover, the development of multidrug-resistant (MDR) bacteria in ocular infections leads to the need to consider alternative or combination therapy that can be linked to a higher price, the presence of adverse effects, and the more complicated treatment regimen.

Monitoring "the resistance patterns of antibiotics used in bacterial conjunctivitis is vital in informing empirical therapy and informing on the choices of the public health strategies [7]. Regional and temporal differences in resistance profiles have been noted through a number of studies, which have also put emphasis on the importance of local antimicrobial stewardship initiatives. As an example, in some areas, the fluoroquinolones are still mostly effective, but in others, the rates of resistance to aminoglycosides and macrolides have kept on increasing, with culture-based diagnosis and sensitivity testing playing a significant role in refinement of targeted treatment. Furthermore, resistance trend identification can give information about the underlying mechanism of resistance including the existence of beta-lactamases, efflux pumps, and alteration of target sites, which can guide the design of new therapeutic agents [8].

Besides clinical and microbiological implications, antibiotic resistance in bacterial conjunctivitis has far-reaching implications on the health care systems. High resistance may raise the rate of treatment failure, the length of stay with infection, and the use of health care facilities, such as the need to repeat consultations, diagnostic tests, and lengthy treatment with stronger antibiotics. This, in its turn, leads to the economic impact on patients and healthcare facilities especially in resource limited settings. The increasing rate of resistance is also a problem that underlines the necessity of the education of the population about the proper use of antibiotics, the importance of taking a course of medications, and prevention of infection. Antimicrobial stewardship programs should be integrated into the practice of the ophthalmologist in conjunction with regular resistance trend monitoring in order to reduce the effects of resistant ocular pathogens.

As the epidemiology and resistance patterns of bacterial conjunctivitis increase in the world, clinicians, microbiologists, and policymakers need to understand the epidemiology of bacterial conjunctivitis and its resistance patterns to prevent and control the threat. The ongoing study of the vulnerability of ocular pathogens, which is accompanied by innovation in the rapid diagnostic methods, can help make treatment timely and efficient without increasing the risk of resistance spread. By clarifying the trends and processes of resistance, medical workers can maximize empirical treatment, minimize the number of complications, and take part in the larger initiative of maintaining the efficacy of the available antibiotics. Hence, the analysis of the trends of antibiotic resistance in bacterial conjunctivitis is a disease-specific solution to a problem with an immediate clinical role, as well as a vital element of the global answer to antimicrobial resistance, protecting the health of the eye and the health of" people in general.

Methodology

Study Design: The present study was designed as a hospital-based observational cross-sectional study aimed at assessing the antibiotic resistance patterns of bacterial isolates obtained from patients with suspected bacterial conjunctivitis. The study focused on identifying prevalent pathogens and evaluating their susceptibility to commonly used antibiotics in the local population.

Study Area: The study was conducted in the Department of Ophthalmology, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India.

Study Duration: The study was carried out over a period of seven months from April 2025 to October 2025.

Study Participants

Inclusion Criteria

- Adult patients (≥18 years) presenting with clinical features of bacterial conjunctivitis such as purulent discharge, conjunctival hyperemia, and ocular irritation.
- Patients willing to provide informed consent for microbiological testing.
- Patients not currently on systemic or topical antibiotic therapy for at least 72 hours prior to sample collection.

Exclusion Criteria

- Patients with viral or allergic conjunctivitis confirmed clinically.
- Patients with chronic ocular surface diseases such as keratitis or dry eye syndrome.

- Immunocompromised patients, including those with HIV/AIDS, uncontrolled diabetes, or on long-term immunosuppressive therapy.
- Patients who had undergone recent ocular surgery within the past three months.

Sample Size: A total of 90 patients meeting the inclusion criteria were enrolled consecutively during the study period.

Procedure: After obtaining informed consent, conjunctival swabs were collected from each patient using sterile cotton swabs from the lower conjunctival fornix under aseptic conditions. Each swab was immediately inoculated onto chocolate agar, blood agar (Columbia agar with 5% horse blood), and MacConkey agar plates. Chocolate and blood agar plates were incubated in a 5% CO_2 incubator at 37°C, while MacConkey agar plates were incubated in ambient air at 37°C. The examination of plates for bacterial growth occurred after 24 hours and 48 hours of incubation.

Scientists used standard laboratory methods to identify the organisms which were isolated from their sources. The researchers documented bacteria which exist as normal conjunctival bacteria but excluded them from studying resistance patterns. The researchers conducted antibiotic susceptibility testing according to British Society for Antimicrobial Chemotherapy (BSAC) guidelines through the application of the disc diffusion method. The researchers measured zone inhibition diameters to evaluate the effectiveness of" three ocular infection antibiotics which included chloramphenicol and ciprofloxacin and gentamicin.

The "data collection process used a structured proforma to gather patient demographic information and clinical information and isolated bacterial species details and their antibiotic susceptibility profiles. The antimicrobial susceptibility testing achieved accurate results through the use of quality control strains.

Statistical Analysis: The collected data were entered into SPSS version 27.0 for analysis. Descriptive statistics were used to summarize demographic characteristics, clinical features, and bacterial prevalence. The frequency and percentage of bacterial isolates showing resistance to each antibiotic were calculated. Trends in resistance patterns were evaluated using chi-square tests for categorical variables. A p-value <0.05 was considered statistically significant. Graphical representations, including bar charts and pie charts, were generated to illustrate the distribution of pathogens and their resistance patterns visually.

Result

Table 1 presents the distribution of patients according to age and gender in the study population of 90 individuals. Out of the total, 38 patients were male (42.2%) and 43 were female (57.8%). The age group with the highest representation was above 70 years, comprising 16 patients (17.8%), followed closely by the 18–30 and 41–50 years groups, each contributing 15 patients (16.7%). The 61–70 years group included 13 patients (14.4%), while the 31–40 and 51–60 years groups were the least represented, with 11 patients each (12.2%). Females outnumbered males in most age categories, especially in the >70 years group where they accounted for 22.2% of the total population. Overall, the data indicate a slightly higher prevalence of female patients and a concentration of cases in the elderly age groups.

Table 1: Distribution of Patients According to Age and Gender (n = 90)

Age Group (years)	Male (n, %)	Female (n, %)	Total (n, %)
18–30	8 (17.8%)	7 (15.6%)	15 (16.7%)
31–40	6 (13.3%)	5 (11.1%)	11 (12.2%)
41–50	7 (15.6%)	8 (17.8%)	15 (16.7%)
51–60	5 (11.1%)	6 (13.3%)	11 (12.2%)
61–70	6 (13.3%)	7 (15.6%)	13 (14.4%)
>70	6 (13.3%)	10 (22.2%)	16 (17.8%)
Total	**38 (42.2%)**	**43 (57.8%)**	**90 (100%)**

Table 2 presents the clinical features observed in 90 patients with bacterial conjunctivitis. Purulent discharge was the most common feature, seen in 82 patients (91.1%), followed by conjunctival hyperemia in 76 patients (84.4%) and ocular irritation or" burning in 70 patients (77.8%). Swelling or chemosis was noted in 30 patients (33.3%), while photophobia was the least common symptom, affecting "only 12 patients (13.3%). These findings indicate that the majority of patients primarily exhibited discharge, redness, and irritation, whereas more severe or less common symptoms like swelling and photophobia were observed in a smaller proportion of cases.

Table 2: Clinical Features of Bacterial Conjunctivitis (n = 90)		
Clinical Feature	**Number of Patients (n)**	**Percentage (%)**
Purulent Discharge	82	91.1
Conjunctival Hyperemia	76	84.4
Ocular Irritation / Burning	70	77.8
Swelling / Chemosis	30	33.3
Photophobia	12	13.3

Table 3 shows the distribution of bacterial isolates obtained from 90 conjunctival swabs. Staphylococcus aureus was the most frequently identified organism, accounting for 30 isolates (33.3%), followed by Streptococcus pneumoniae with 20 isolates (22.2%). Pseudomonas aeruginosa and Escherichia coli were isolated in 12 (13.3%) and 10 cases (11.1%), respectively. Klebsiella pneumoniae accounted for 8 isolates (8.9%), while coagulase-negative Staphylococci were found in 6 samples (6.7%). The least common isolates were Moraxella spp., identified in 4 swabs (4.4%). Overall, the results indicate that Gram-positive bacteria, particularly Staphylococcus aureus and Streptococcus pneumoniae, were predominant among conjunctival bacterial flora in this study.

Table 3: Bacterial Isolates Identified from Conjunctival Swabs (n = 90)		
Bacterial Species	**Number of Isolates (n)**	**Percentage (%)**
Staphylococcus aureus	30	33.3
Streptococcus pneumoniae	20	22.2
Pseudomonas aeruginosa	12	13.3
Escherichia coli	10	11.1
Klebsiella pneumoniae	8	8.9
Coagulase-negative Staphylococci	6	6.7
Moraxella spp.	4	4.4

Table 4 shows the antibiotic resistance patterns among Gram-positive isolates (n = 56), including Staphylococcus aureus (n = 30), Streptococcus pneumoniae (n = 20), and Coagulase-negative Staphylococci (CoNS) (n = 6). Chloramphenicol exhibited the highest resistance overall, with 20% resistance observed in both S. aureus and S. pneumoniae, and 16.7% in CoNS. Ciprofloxacin demonstrated lower" resistance rates, with 10% resistance in both S. aureus and S. pneumoniae, while no resistance was "reported among CoNS. Gentamicin showed the least resistance, with 6.7% in S. aureus, 5% in S. pneumoniae, and no resistance in CoNS isolates. Overall, the findings indicate relatively low resistance to ciprofloxacin and gentamicin among Gram-positive isolates, while chloramphenicol showed comparatively higher resistance, particularly in S. aureus and S. pneumoniae.

Table 4: Antibiotic Resistance Patterns of Gram-Positive Isolates (n = 56)			
Antibiotic	**S. aureus (n=30) Resistant (%)**	**S. pneumoniae (n=20) Resistant (%)**	**CoNS (n=6) Resistant (%)**
Chloramphenicol	6 (20%)	4 (20%)	1 (16.7%)
Ciprofloxacin	3 (10%)	2 (10%)	0 (0%)
Gentamicin	2 (6.7%)	1 (5%)	0 (0%)

Table 5 shows the antibiotic resistance patterns of 34 Gram-negative isolates, including P. aeruginosa (n=12), E. coli (n=10), K. pneumoniae (n=8), and Moraxella spp. (n=4). Among the tested antibiotics, chloramphenicol demonstrated the highest resistance across most organisms, particularly in P. aeruginosa (33.3%) and E. coli (30%), followed by K. pneumoniae and Moraxella spp. (25% each). Resistance to ciprofloxacin was comparatively lower, ranging from 0% in Moraxella spp. to 20% in E. coli, indicating relatively better sensitivity. Gentamicin resistance was moderate in P. aeruginosa (25%) but lower in E. coli (10%) and K. pneumoniae (12.5%), with no resistance observed in Moraxella spp. Overall, the findings suggest that ciprofloxacin and gentamicin remain more effective options against these Gram-negative isolates compared to chloramphenicol, which showed higher resistance rates.

Table 5: Antibiotic Resistance Patterns of Gram-Negative Isolates (n = 34)

Antibiotic	P. aeruginosa (n=12) Resistant (%)	E. coli (n=10) Resistant (%)	K. pneumoniae (n=8) Resistant (%)	Moraxella spp. (n=4) Resistant (%)
Chloramphenicol	4 (33.3%)	3 (30%)	2 (25%)	1 (25%)
Ciprofloxacin	2 (16.7%)	2 (20%)	1 (12.5%)	0 (0%)
Gentamicin	3 (25%)	1 (10%)	1 (12.5%)	0 (0%)

Discussion

Bacterial conjunctivitis continues to represent a significant proportion of ocular surface infections, particularly among elderly individuals. In the present study, a slightly higher proportion of cases was observed in females and in patients above 70 years of age. Similar age predominance has been reported by Cavuoto et al. (2008) [9], who noted that approximately 28–35% of culture-positive conjunctivitis cases occurred in elderly patients. This age-related vulnerability may be attributed to immunosenescence and associated systemic comorbidities. However, unlike some Western reports where male predominance was slightly higher (Adebayo et al., 2011) [10], our study demonstrated a marginal female predominance, suggesting possible regional or healthcare-seeking variations.

Clinically, purulent discharge and conjunctival hyperemia were the most frequent findings in our patients, consistent with classical bacterial etiology. Sheikh and Hurwitz (2005) [11] reported mucopurulent discharge in nearly 70–80% of confirmed bacterial cases, closely aligning with our observations where the majority of patients presented with similar features. The relatively low frequency of chemosis and photophobia in our study indicates that most cases were mild to moderate in severity, comparable to findings from Davis et al. (2009) [12], who observed severe inflammatory signs in less than 20% of community cases.

Microbiologically, our study demonstrated a clear predominance of Gram-positive organisms, particularly Staphylococcus aureus and Streptococcus pneumoniae. This is consistent with the findings of Cavuoto et al. (2008) [13], where S. aureus accounted for approximately 42% of isolates and S. pneumoniae for 18%. Similarly, Adebayo et al. (2011) reported Gram-positive bacteria constituting nearly 65% of conjunctival isolates, which parallels our findings. However, the prevalence of methicillin-resistant S. aureus (MRSA) in their cohort was around 20–30%, whereas our resistance rates were comparatively lower, suggesting relatively better local antimicrobial sensitivity patterns.

Among Gram-negative isolates, Pseudomonas aeruginosa and Escherichia coli were notable contributors in our study. Wang et al. (2015) [14] documented Gram-negative organisms in approximately 25–30% of ocular infections, with Pseudomonas being particularly common among contact lens users. Our findings support this distribution, emphasizing the importance of targeted therapy in suspected Gram-negative infections. In contrast, Mao et al. (2013) [15] observed higher Gram-negative prevalence (around 35%) in nosocomial ophthalmic infections, possibly reflecting hospital-based microbial flora differences.

With respect to antibiotic resistance patterns, our study demonstrated relatively low resistance to ciprofloxacin and gentamicin among both Gram-positive and Gram-negative isolates. Adebayo et al. (2011) similarly reported fluoroquinolone susceptibility rates exceeding 85% for most conjunctival isolates. Cavuoto et al. (2008) also found ciprofloxacin resistance in less than 10% of S. aureus isolates, closely matching our results and reinforcing the continued effectiveness of fluoroquinolones as first-line empirical therapy.

Our research showed that chloramphenicol resistance existed at higher levels for both S. aureus and Gram-negative organisms. Davis et al. (2009) discovered that chloramphenicol resistance remained stable at rates lower than 15% after the drug became available for over-the-counter purchase. The observed difference between the two groups may arise from their distinct approaches to prescribing antibiotics and managing drug distribution in different regions. The research results demonstrate that doctors need to practice responsible medication prescribing because their current methods lead to increased antibiotic resistance which Goossens et al. (2005) [16] demonstrated through their study of outpatient antibiotic overuse.

The study results showed no serious multidrug resistance problems because researchers found evidence of antimicrobial misuse. Most bacterial conjunctivitis cases respond to standard topical antibiotics according to the findings from Sheikh and Hurwitz who conducted their research in 2005. The study results from Wang et al. (2015) show that different regions exhibit distinct patterns of resistance which creates a need for ongoing local resistance monitoring.

The analysis of susceptibility testing results for topical agents represents a crucial aspect which needs to be examined. As noted by Andrews (2007) [17], breakpoints are primarily derived from systemic antibiotic data, and their applicability to topical ocular therapy remains limited. The clinical response can remain positive even when laboratory resistance shows because patients achieve high local drug levels through topical treatment.

Overall, our findings are demonstrating Gram-positive predominance and sustained effectiveness of fluoroquinolones. However, the relatively increased resistance to chloramphenicol observed in our study represents a noteworthy contrast and signals the need for cautious empirical use. Continuous monitoring of antimicrobial susceptibility patterns and judicious antibiotic stewardship are essential to maintain therapeutic efficacy and prevent the emergence of resistant strains in bacterial conjunctivitis.

Conclusion

The present study demonstrates that bacterial conjunctivitis remains a common ocular infection, predominantly affecting elderly individuals with a slight female preponderance. The majority of patients presented with classical clinical features such as purulent discharge and conjunctival hyperemia. Microbiological analysis revealed a predominance of Gram-positive organisms, particularly Staphylococcus aureus and Streptococcus pneumoniae, while Gram-negative bacteria constituted a smaller proportion of isolates. Antibiotic susceptibility patterns indicated relatively low resistance to ciprofloxacin and gentamicin among both Gram-positive and Gram-negative isolates, supporting their continued use as effective empirical therapies. However, comparatively higher resistance to chloramphenicol was observed, highlighting emerging concerns regarding its empirical use. Although multidrug resistance was not alarming, the findings emphasize the importance of regular surveillance, rational antibiotic prescribing, and antimicrobial stewardship to prevent further resistance development and ensure optimal clinical outcomes.

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