Section: Miscellaneous

Original Research Article

PROSPECTIVE STUDY ON BACTERIAL GROWTH IN CONTACT LENS USERS BEFORE AND AFTER HYGIENE EDUCATION

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ABSTRACT

Background: Contact lenses are widely used for refractive correction and cosmetic purposes; however, improper handling and inadequate hygiene practices can lead to microbial contamination of contact lenses and their storage cases. Such contamination increases the risk of contact lens–related ocular infections, including microbial keratitis, which may result in serious visual morbidity. Hygiene education is a key preventive strategy, yet its measurable impact on bacterial growth among contact lens users in routine clinical settings requires further evaluation. **Aim:** To assess bacterial growth in contact lens users before and after hygiene education and to evaluate the effectiveness of structured hygiene education in reducing microbial contamination.

Materials and Methods: This prospective observational study was conducted at a tertiary care hospital and included 110 contact lens users attending the ophthalmology outpatient department. Demographic data, contact lens usage patterns, and hygiene practices were recorded using a structured proforma. Samples were collected from contact lenses and lens storage cases under aseptic conditions and cultured on appropriate media for bacterial isolation and identification using standard microbiological techniques. Following baseline sample collection, all participants received structured hygiene education focusing on hand hygiene, lens cleaning and disinfection, proper storage case maintenance, and safe lens-wearing practices. Post-education samples were collected and processed using identical methods. Data were analyzed using SPSS version 26.0, and statistical significance was determined with a p-value <0.05.

Results: Before hygiene education, bacterial growth was detected in 66 participants (60.00%), while 44 (40.00%) showed no growth. After hygiene education, bacterial growth significantly decreased to 28 participants (25.45%), with 82 (74.55%) showing no growth (p <0.001). *Staphylococcus aureus* was the most common isolate before education (25.45%), followed by coagulase-negative *Staphylococci* (16.36%) and *Pseudomonas aeruginosa* (10.91%). Significant reductions were observed in these isolates after education (p <0.05). Inadequate cleaning and improper storage case hygiene were strongly associated with bacterial growth prior to education (p <0.001).

Conclusion: The study demonstrates that inadequate contact lens hygiene is associated with high rates of bacterial contamination. Structured hygiene education significantly reduces bacterial growth and pathogenic isolates among contact lens users. Incorporating regular hygiene counseling into routine ophthalmic practice may help prevent contact lens–related ocular infections.

Keywords: Contact lens hygiene; Bacterial contamination; Hygiene education; Contact lens users; Microbial growth.

INTRODUCTION

Contact lenses are a widely used and effective option for refractive correction and cosmetic purposes, particularly among adolescents and young adults. Despite their benefits, contact lens wear is not risk-free, because the lens surface, lens case, and care solutions can act as vehicles for microbial transfer to the ocular surface when handling and hygiene practices are inadequate. Population-based evidence has shown that risky behaviors related to contact lens wear and care are extremely common in routine users, highlighting a large preventable component of contact lens–associated complications.[1] Among the spectrum of adverse events, microbial keratitis remains the most serious complication because it may progress rapidly and lead to corneal scarring, reduced vision, or the need for hospital-based care. Large surveillance data have demonstrated that the incidence of contact lens–related microbial keratitis, while relatively low at a population level, remains clinically significant due to the high number of contact lens users and the potential for severe morbidity.[2] The risk of infection is not uniform across all lens modalities and behaviors. Case-control evidence has consistently identified strong associations between microbial keratitis and modifiable factors such as overnight wear, extended daily wear, and poor lens-care practices. In contemporary contact lens use, these risk factors remain relevant and help explain why preventable infections continue to occur even with improved lens materials and modern multipurpose solutions.[3] The pathogenesis of contact lens–related infection is multifactorial and involves microbial exposure, microbial survival within the lens-care ecosystem, and disruption of the corneal epithelial barrier. Reviews of contact lens–related microbial keratitis emphasize that certain organisms—particularly Pseudomonas aeruginosa—remain prominent causes due to their virulence traits and ability to persist in the lens, storage case, and ocular environment. In addition, delays in recognition of symptoms and delayed presentation for treatment may increase morbidity, making prevention and patient education essential components of clinical care.[4] Microbial contamination of contact lenses and their accessories is common even in asymptomatic wearers. Evidence synthesizing decades of microbiological studies indicates that lens handling can substantially increase contamination, and that more than half of worn lenses may harbor microorganisms, most commonly bacteria. Lens cases, in particular, function as reservoirs that can support survival and biofilm formation, which may reduce disinfectant effectiveness and contribute to repeated recontamination of lenses after cleaning.[5] Because contamination is strongly linked to daily behaviors, prevention strategies increasingly focus on improving compliance with lens hygiene, case hygiene, and correct disinfection steps. Importantly, even when users report "cleaning," the specific steps performed (rubbing, rinsing, air-drying, and tissue-wiping of cases) can vary considerably and influence the microbial load remaining in the storage case. Interventional clinical data demonstrate that modifying case-care instructions and reinforcing more effective cleaning steps can reduce viable microbial contamination in lens cases compared with standard manufacturer guidance.[6] Patient education is therefore a core preventive measure in contact lens practice, but achieving sustained behavior change can be challenging. Earlier prospective work evaluating enhanced educational strategies (such as supplemental videos, printed materials, reminders, and structured reinforcement) illustrates both the importance of education and the difficulty of producing measurable long-term improvements in compliance within real-world settings. Nevertheless, education remains central because it targets the most modifiable contributors to contamination and infection risk: hand hygiene, disinfection technique, case maintenance, replacement habits, and avoidance of water exposure or unadvised overnight wear.[7]

MATERIALS AND METHODS

This prospective observational study was conducted at a tertiary care hospital with the objective of assessing bacterial growth among contact lens users before and after hygiene education. The study focused on evaluating the microbiological profile associated with contact lens use and determining the impact of structured hygiene education on bacterial contamination. A total of 110 contact lens users attending the ophthalmology outpatient department of the tertiary care hospital were enrolled in the study. Participants included both male and female contact lens users who were actively using contact lenses at the time of recruitment. Patients were selected based on predefined inclusion and exclusion criteria to ensure uniformity and reliability of results.

Inclusion and Exclusion Criteria

Individuals aged 18 years and above who were regular contact lens users and consented to participate were included in the study. Participants using either soft or rigid contact lenses were considered eligible. Patients with active ocular infections, recent ocular surgery, current use of topical or systemic antibiotics, or underlying immunocompromised conditions were excluded to avoid confounding factors affecting bacterial growth.

Methodology

A detailed clinical and demographic profile was recorded for each participant using a structured proforma. Information regarding age, gender, type of contact lens, duration of daily lens wear, lens replacement schedule, cleaning practices, and storage habits was documented. A comprehensive ocular examination was performed to assess any signs of ocular surface abnormalities or inflammation.

Samples were collected from contact lenses and lens storage cases under strict aseptic precautions. Sterile swabs moistened with normal saline were used to obtain specimens, which were immediately transported to the microbiology laboratory for processing. Samples were inoculated onto appropriate culture media, including blood agar and MacConkey agar, and incubated under standard conditions. Bacterial growth was identified based on colony morphology, Gram staining, and standard biochemical tests.

Following baseline sample collection, all participants received structured hygiene education. The educational intervention included verbal counseling and demonstration of proper contact lens hygiene practices, such as hand washing before lens handling, appropriate cleaning and disinfection techniques, correct storage case maintenance, avoidance of overnight lens wear unless prescribed, and adherence to lens replacement schedules. Educational material was standardized and delivered uniformly to all participants.

After the hygiene education intervention, repeat samples were collected from the same participants using identical methods and aseptic precautions. These samples were processed similarly to evaluate changes in bacterial growth patterns following the educational intervention.

The primary outcome measure was the presence or absence of bacterial growth before and after hygiene education. Secondary outcome measures included the type of bacterial isolates identified and the comparison of bacterial load in relation to contact lens hygiene practices.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics were used to summarize demographic and clinical variables. Categorical variables were expressed as frequencies and percentages. Comparative analysis of bacterial growth before and after hygiene education was performed using appropriate statistical tests, with a p-value of less than 0.05 considered statistically significant.

RESULTS

Table 1: Demographic Characteristics of Study Participants

Table 1 summarizes the demographic profile of the 110 contact lens users included in the study. Females constituted the majority of participants, with 64 individuals (58.18%), while males accounted for 46 participants (41.82%). This indicates a higher prevalence of contact lens usage among female patients in the study population. The age distribution revealed that most participants belonged to the younger age groups. The highest proportion was observed in the 26–35 years age group, comprising 44 participants (40.00%), followed by the 18–25 years group with 38 participants (34.55%). Together, these two groups accounted for more than two-thirds of the study population. Participants aged 36–45 years represented 18.18%, while those above 45 years constituted the smallest group at 7.27%.

Table 2: Contact Lens Usage and Hygiene Practices Before Education

Table 2 describes the pattern of contact lens usage and hygiene practices among participants before hygiene education. A large majority of the participants used soft contact lenses, with 92 individuals (83.64%), whereas rigid contact lenses were used by only 18 participants (16.36%). Regarding the daily duration of lens wear, 56 participants (50.91%) reported wearing contact lenses for more than 8 hours per day, while 54 participants (49.09%) wore them for 8 hours or less, indicating prolonged daily lens use in nearly half of the users. Notably, inadequate cleaning practices were reported by 68 participants (61.82%), and improper storage case hygiene was observed in 72 participants (65.45%).

Table 3: Bacterial Growth Before and After Hygiene Education

Table 3 compares the presence of bacterial growth before and after hygiene education. Before education, bacterial growth was detected in 66 participants (60.00%), while 44 participants (40.00%) showed no growth. Following hygiene education, a marked reduction in bacterial growth was observed, with only 28 participants (25.45%) showing bacterial growth and 82 participants (74.55%) showing no growth. The reduction in bacterial growth after education was statistically highly significant ($p < 0.001$).

Table 4: Distribution of Bacterial Isolates Before and After Education

Table 4 presents the distribution of bacterial isolates identified before and after hygiene education. *Staphylococcus aureus* was the most commonly isolated organism before education, detected in 28 participants (25.45%). After education, its prevalence significantly decreased to 12 participants (10.91%), with a statistically significant p-value of 0.004. Coagulase-negative *Staphylococci* were isolated in 18 participants (16.36%) before education and decreased to 8 participants (7.27%) after education, showing a significant reduction ($p = 0.032$). *Pseudomonas aeruginosa*, an important ocular pathogen, was identified in 12 participants (10.91%) before education and reduced to 4 participants (3.64%) after education, which was also statistically significant ($p = 0.041$). Although *Escherichia coli* and mixed bacterial growth showed a numerical reduction after education, these changes were not statistically significant ($p = 0.248$ and $p = 0.654$, respectively).

Table 5: Association Between Hygiene Practices and Bacterial Growth Before Education

Table 5 illustrates the association between hygiene practices and bacterial growth prior to hygiene education. Among participants with inadequate cleaning practices ($n = 68$), bacterial growth was present in 52 individuals (76.47%), while only 16 individuals (23.53%) showed no growth. In contrast, among those with adequate cleaning practices (n = 42), bacterial growth was observed in only 14 participants (33.33%), and no growth was seen in 28 participants (66.67%). This association was statistically significant (p < 0.001). Similarly, among participants with improper storage case hygiene (n = 72), bacterial growth was present in 54 individuals (75.00%), compared to only 12 individuals (31.58%) with proper case hygiene. This association was also statistically highly significant (p < 0.001).

Table 1: Demographic Characteristics of Study Participants (n = 110)

Variable	Number (n)	Percentage (%)
Gender		
Male	46	41.82
Female	64	58.18
Age Group (years)		
18–25	38	34.55
26–35	44	40.00
36–45	20	18.18
>45	8	7.27

Table 2: Contact Lens Usage and Hygiene Practices Before Education (n = 110)

Parameter	Number (n)	Percentage (%)
Type of Contact Lens		
Soft lenses	92	83.64
Rigid lenses	18	16.36
Daily Duration of Lens Wear		
≤8 hours	54	49.09
>8 hours	56	50.91
Inadequate Cleaning Practices	68	61.82
Improper Storage Case Hygiene	72	65.45

Table 3: Bacterial Growth Before and After Hygiene Education (n = 110)

Bacterial Growth Status	Before Education n (%)	After Education n (%)	p-value
Growth Present	66 (60.00)	28 (25.45)	<0.001
No Growth	44 (40.00)	82 (74.55)	

Table 4: Distribution of Bacterial Isolates Identified Before and After Education

Bacterial Isolate	Before Education n (%)	After Education n (%)	p-value
Staphylococcus aureus	28 (25.45)	12 (10.91)	0.004
Coagulase-negative *Staphylococci*	18 (16.36)	8 (7.27)	0.032
Pseudomonas aeruginosa	12 (10.91)	4 (3.64)	0.041
Escherichia coli	5 (4.55)	2 (1.82)	0.248
Mixed bacterial growth	3 (2.73)	2 (1.82)	0.654

Table 5: Association Between Hygiene Practices and Bacterial Growth Before Education (n = 110)

Hygiene Practice	Growth Present n (%)	No Growth n (%)	p-value
Inadequate cleaning (n = 68)	52 (76.47)	16 (23.53)	<0.001
Adequate cleaning (n = 42)	14 (33.33)	28 (66.67)	
Improper case hygiene (n = 72)	54 (75.00)	18 (25.00)	<0.001
Proper case hygiene (n = 38)	12 (31.58)	26 (68.42)	

DISCUSSION

In the present study, females constituted 58.18% (64/110) of contact lens users and the most represented age group was 26–35 years (40.00%), reflecting greater uptake in younger adults. A similar demographic trend has been reported by Ezinne et al. (2022), where females accounted for 64.20% of contact lens wearers and the majority were young adults (59.70% in the 18–30-year group), supporting the view that contact lens use is more common among young females in many settings.[8]

Regarding lens-wear characteristics, soft lenses predominated in our cohort (83.64%), and prolonged daily wear was common, with 50.91% reporting >8 hours/day. Rueff et al. (2019) similarly highlighted substantial non-adherence in soft lens wearers, including non-compliance with the replacement schedule in 38.70% and non-compliance with prescribed overnight wear in 23.90%, indicating that risky wearing patterns remain frequent even among routine users and may contribute to microbial contamination risk.[9]

Before education, hygiene behaviors in our study were suboptimal, with inadequate cleaning in 61.82% and improper storage case hygiene in 65.45%. Comparable deficits were observed by Alonso et al. (2024), where 52.20% of participants reported not always washing hands before storage case manipulation (and 17.80% not always before contact lens handling), reinforcing that incomplete hygiene adherence is widespread and provides a plausible pathway for contamination.[10]

Microbiologically, bacterial growth was detected in 60.00% of participants before education in our study. This aligns closely with Wu et al. (2010), who reported contamination in 58.00% (37/64) of contact lens cases, indicating that baseline contamination levels around ~60% are consistently reported across different populations and sampling strategies.[11]

The organism profile in our participants showed Staphylococcus aureus as the most frequent isolate before education (25.45%), followed by coagulase-negative staphylococci (16.36%) and Pseudomonas aeruginosa (10.91%). In contrast, Rahim et al. (2008) reported markedly higher contamination in contact lens cases (89.00%) and lenses (65.00%), with P. aeruginosa dominating storage-case isolates (41.60%) and S. aureus being less frequent in cases (5.60%), suggesting that local environment, behaviors (e.g., water exposure), and sampling sites can shift the dominant organism spectrum even when contamination remains common.[12]

After structured hygiene education in our study, bacterial growth decreased from 60.00% to 25.45% ($p<0.001$), indicating a substantial reduction following counseling and demonstration. By comparison, Arshad et al. (2021) found that a targeted educational cue ("no-water" case sticker) reduced overall water-exposure score and endotoxin levels ($p<0.05$) but did not significantly change overall storage-case contamination, suggesting that broader hygiene education (as delivered in our study) may yield a larger measurable effect on culture-based growth than narrower messaging focused on a single behavior.[13]

The strong association between hygiene and contamination in our cohort supports a biologically plausible mechanism: growth was present in 76.47% of those with inadequate cleaning versus 33.33% with adequate cleaning ($p<0.001$), and in 75.00% with improper case hygiene versus 31.58% with proper case hygiene ($p<0.001$). McMonnies et al. (2012) similarly emphasized the critical role of hand-related transfer, noting that contamination can be markedly lower with aseptic approaches (reported as low as 4.00% with aseptic lens removal) compared with typical handling, underscoring why improvements in hand/case hygiene can translate into reduced bacterial recovery.[14]

Finally, the post-education decline in key pathogens in our study—S. aureus (25.45% to 10.91%, $p=0.004$), coagulase-negative staphylococci (16.36% to 7.27%, $p=0.032$), and P. aeruginosa (10.91% to 3.64%, $p=0.041$) is consistent with the broader evidence that lens-case contamination is commonly >50% and frequently involves coagulase-negative staphylococci and Pseudomonas, among others. Wu et al. (2015) highlighted both the high background contamination burden and the central preventive role of improved hygiene behaviors and case care, which supports interpreting our reductions as clinically meaningful and prevention-oriented.[15]

CONCLUSION

This prospective study demonstrates a high prevalence of bacterial contamination among contact lens users, largely associated with inadequate hygiene and improper storage case practices. Structured hygiene education resulted in a statistically significant reduction in overall bacterial growth and pathogenic isolates. The findings highlight the critical role of patient education in improving contact lens hygiene and reducing microbiological risk. Regular reinforcement of proper lens care practices should be integrated into routine clinical care to prevent contact lens–related ocular infections.

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