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Original Research Article

STUDY OF MICROBIAL GROWTH DETECTION BY RESIN-BASED CULTURE MEDIA AND ANTIMICROBIAL SUSCEPTIBILITY TESTING IN CLINICALLY SUSPECTED CASES OF ENDOPHTHALMITIS

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ABSTRACT

Background: Present study was conducted to determine microbial growth detection using resin-based culture media and evaluate the antimicrobial susceptibility pattern of isolates recovered from clinically suspected cases of endophthalmitis.

Materials and Methods: A hospital-based observational study was conducted in the Department of Microbiology in collaboration with the Western Regional Institute of Ophthalmology at a tertiary care teaching hospital from December 2023 to February 2025. A total of 100 consecutive intraocular specimens obtained from clinically suspected cases of endophthalmitis were processed using resin-based automated blood culture media. Culture-positive isolates were identified using standard microbiological techniques, and antimicrobial susceptibility testing was performed by the Kirby–Bauer disc diffusion method according to Clinical and Laboratory Standards Institute guidelines.

Results: Among 100 clinically suspected cases, 30 (30%) yielded positive cultures. Gram-positive cocci were the predominant isolates (53.3%), followed by Gram-negative bacilli (40.0%), Gram-positive bacilli (3.3%), and fungi (3.3%). Methicillin-sensitive Staphylococcus epidermidis was the most frequently isolated organism (30.0%), followed by methicillin-sensitive Staphylococcus aureus (16.7%) and Pseudomonas species (20.0%). Gram-positive isolates demonstrated 100% susceptibility to vancomycin, amikacin, tobramycin, and fosfomycin, whereas Gram-negative isolates showed complete susceptibility to carbapenems, aminoglycosides, and selected fluoroquinolones. Lower susceptibility was observed for ciprofloxacin and cefotaxime among Gram-positive isolates and for tetracycline, polymyxin B, and piperacillin among Gram-negative isolates.

Conclusion: Resin-based automated culture media provided satisfactory microbiological yield in clinically suspected endophthalmitis and facilitated identification of the predominant pathogens and their antimicrobial susceptibility patterns. Gram-positive cocci, particularly Staphylococcus epidermidis, remained the leading causative organisms, while vancomycin for Gram-positive isolates and carbapenems with aminoglycosides for Gram-negative isolates demonstrated excellent in vitro activity. Periodic surveillance of local microbial epidemiology and antimicrobial susceptibility is essential to guide empirical therapy and optimize the management of endophthalmitis.

Keywords: Endophthalmitis, Resin-based culture media, Automated blood culture system, Microbial profile, Antimicrobial susceptibility.

INTRODUCTION

Endophthalmitis is a severe intraocular inflammatory condition, most commonly caused by microbial infection following intraocular surgery, penetrating ocular trauma, or, less frequently, endogenous hematogenous spread. Despite advances in ophthalmic surgery and antimicrobial therapy, it remains one of the most vision-threatening ophthalmic emergencies because delayed diagnosis and inappropriate treatment can rapidly lead to irreversible visual impairment or blindness. Early identification of the causative organism and prompt institution of appropriate antimicrobial therapy are therefore critical for preserving visual function and improving clinical outcomes.[1-3]

The microbiological spectrum of endophthalmitis varies according to geographical location, patient characteristics, type of ocular insult, and local antimicrobial prescribing practices. Gram-positive bacteria, particularly coagulase-negative Staphylococcus species, are the predominant pathogens in postoperative infections, whereas Gram-negative organisms and filamentous fungi are more frequently associated with post-traumatic infections in tropical countries.[4-6] As microbial epidemiology and antimicrobial resistance patterns continue to evolve, periodic surveillance of the local pathogen profile is essential for guiding empirical therapy and antimicrobial stewardship.[7]

Microbiological diagnosis of endophthalmitis is often challenging because only a small volume of intraocular fluid is available for analysis, and prior antimicrobial exposure may reduce culture positivity.[8] Conventional culture methods may therefore fail to recover viable organisms in a substantial proportion of clinically suspected cases.[9] Resin-based automated blood culture systems have been increasingly adopted for processing intraocular specimens because they facilitate recovery of microorganisms from low-volume samples while neutralizing residual antimicrobial agents, thereby enhancing the likelihood of pathogen isolation in routine laboratory practice.[10,11] However, published data regarding their application in ocular specimens remain limited, particularly from the Indian subcontinent.

In addition to identifying the causative organism, antimicrobial susceptibility testing provides valuable information for selecting targeted therapy and monitoring emerging resistance trends.[12] Continuous evaluation of local susceptibility patterns is essential because empirical treatment recommendations should be based on contemporary regional microbiological data rather than historical resistance profiles. Such information also supports evidence-based antimicrobial stewardship and helps optimize clinical management while reducing the risk of treatment failure.[13,14] Therefore, the present study was undertaken to determine the microbial growth detected using resin-based culture media and to evaluate the antimicrobial susceptibility patterns of isolates obtained from clinically suspected cases of endophthalmitis in a tertiary care centre. The findings are expected to provide contemporary local microbiological data that may assist clinicians in selecting appropriate empirical antimicrobial therapy while awaiting definitive culture and susceptibility results.

MATERIALS AND METHODS

Study design, setting and period: A hospital-based observational study was conducted in the Department of Microbiology in collaboration with the Department of Ophthalmology in a tertiary care teaching hospital in western India. The study was carried out over a 15-month period from December 2023 to February 2025.

Study participants: Patients of any age and sex with clinically suspected endophthalmitis presenting to the ophthalmology department and undergoing intraocular fluid sampling as part of routine clinical management were eligible for inclusion. Clinical suspicion of endophthalmitis was based on the presence of severe ocular pain, redness, lacrimation, photophobia, marked diminution of vision, lid edema, conjunctival chemosis, circumcorneal congestion, corneal edema or clouding, hypopyon, vitreous exudation, or a history of recent ocular surgery or ocular trauma. Patients without clinical features suggestive of endophthalmitis, specimens received in unsterile containers, samples of inadequate quantity, or samples with mismatched patient identification were excluded.

Sample size and sampling technique: The study included 100 intraocular specimens obtained from clinically suspected cases of endophthalmitis during the study period. Consecutive sampling was employed, and all eligible specimens received during the study period were included.

Study tool and data collection: Demographic and clinical information, including age, sex, duration of illness, history of ocular trauma, and previous ophthalmic surgery, was recorded using a predesigned study proforma. Depending on the clinical indication, anterior chamber fluid, vitreous fluid, or anterior chamber exudate was collected under aseptic conditions in the operating theatre before initiation of antimicrobial therapy whenever feasible. Approximately 0.2–0.5 mL of intraocular fluid was aspirated using a syringe attached to a vitrectomy cannula and transported immediately to the microbiology laboratory. When the specimen volume was insufficient, the vitrectomy cannula was directly inoculated into glucose broth before transportation. Specimens were inoculated into resin-containing pediatric BacT/ALERT automated blood culture bottles (bioMérieux) and incubated in the BacT/ALERT 3D automated culture system. Culture-positive bottles were subcultured onto

MacConkey agar, Nutrient agar, and Chocolate agar using standard microbiological procedures. Bacterial identification was performed based on colony morphology, Gram staining, and conventional biochemical characteristics. Direct microscopy included Gram staining for all specimens and 10% potassium hydroxide (KOH) wet mount for detection of fungal elements. Fungal isolates were identified by colony morphology on Sabouraud dextrose agar and microscopic examination using lactophenol cotton blue preparation or slide culture whenever required. Antimicrobial susceptibility testing of bacterial isolates was performed on Mueller–Hinton agar using the Kirby–Bauer disc diffusion method according to the Clinical and Laboratory Standards Institute (CLSI) recommendations. Phenotypic detection of extended-spectrum β-lactamase (ESBL), AmpC β-lactamase, methicillin resistance, inducible clindamycin resistance (D-test), and metallo-β-lactamase (MBL) production was performed using standard phenotypic methods wherever applicable.

Study variables and outcome measures: The primary outcome measure was microbial growth detected from intraocular specimens using resin-based automated culture media. Secondary outcomes included the distribution of bacterial and fungal isolates, culture positivity according to specimen type and clinical etiology, Gram stain and KOH findings, antimicrobial susceptibility patterns of bacterial isolates, and detection of selected antimicrobial resistance phenotypes. Independent variables included age, sex, clinical etiology of endophthalmitis (postoperative, post-traumatic, post-corneal ulcer, and other causes), and specimen type (anterior chamber tap, vitreous tap, and anterior chamber exudate). Laboratory variables included direct microscopy findings, culture results, organism identification, antimicrobial susceptibility profiles, and phenotypic resistance mechanisms.

Ethical considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee. Intraocular specimens were collected as part of routine clinical management under aseptic conditions. Patient confidentiality was maintained throughout the study, and all laboratory and clinical data were analyzed anonymously.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software (version 21.0; IBM Corp., Armonk, NY, USA). Continuous variables were summarized using mean and standard deviation or median with range, as appropriate, whereas categorical variables were presented as frequencies and percentages. Associations between categorical variables were evaluated using the Chi-square test or Fisher's exact test, wherever appropriate. A two-sided *P* value of <0.05 was considered statistically significant.

RESULTS

As presented in [Table 1], males constituted almost two-thirds of the study population, and individuals aged 61–70 years were most frequently affected. Anterior chamber tap was the commonest specimen received, while culture positivity was observed in 30% of cases.

Table 1: Clinco-demographic characteristics of study participants (N = 100)

Characteristics	Frequency (n)	Percentage (%)
Age group (years)		
• 0–10	07	7.0
• 11–20	06	6.0
• 21–30	13	13.0
• 31–40	11	11.0
• 41–50	20	20.0
• 51–60	12	12.0
• 61–70	26	26.0
• >70	05	5.0
Sex		
• Male	64	64.0
• Female	36	36.0
Clinical etiology		
• Post-traumatic	38	38.0
• Post-operative	11	11.0
• Post-corneal ulcer	11	11.0
• Others	40	40.0
Specimen type		
• Anterior chamber tap	53	53.0
• Vitreous tap	41	41.0
• Anterior chamber exudate	6	6.0
Resin based -Culture result		
• Positive	30	30.0
• Negative	70	70.0

[Table 2] presents the distribution of microorganisms isolated from culture-positive specimens. Gram-positive cocci were the predominant isolates (53.3%), followed by Gram-negative bacilli (40.0%). Methicillin-sensitive Staphylococcus epidermidis was the most frequently isolated organism (30.0%), whereas Pseudomonas spp. was the leading Gram-negative pathogen (20.0%).

Table 2: Distribution of microorganisms isolated from culture-positive specimens (n = 30)

Microorganism	Numbers	Percentages*
Gram-positive cocci (n = 16)		
Staphylococcus epidermidis (Methicillin-sensitive)	9	30.0
Staphylococcus aureus (Methicillin-sensitive)	5	16.7
Staphylococcus epidermidis (Methicillin-resistant)	1	3.3
Streptococcus spp.	1	3.3
Gram-negative bacilli (n = 12)		
Pseudomonas spp.	6	20.0
Escherichia coli	2	6.7
Non-lactose-fermenting Gram-negative bacilli	2	6.7
Burkholderia spp.	1	3.3
Serratia spp.	1	3.3
Gram-positive bacilli (n = 1)		
Diphtheroids	1	3.3
Fungi (n = 1)		
Fusarium spp.	1	3.3
Total isolates	30	100.0

**Percentages are calculated using the total number of culture-positive isolates (n = 30)*

Table 3 depicts the antimicrobial susceptibility profile of Gram-positive isolates. Vancomycin, amikacin, tobramycin and fosfomycin demonstrated complete (100%) in vitro activity against Gram-positive organisms, while linezolid, cephalexin, ampicillin/sulbactam, tetracycline and cloxacillin also exhibited high susceptibility (>90%). In contrast, cefotaxime and ciprofloxacin showed the lowest susceptibility (18.8%).

Table 3: Antibiotic Sensitivity Percentage (%) Of Gram-Positive Isolates (n=16)

Drug Abbreviation	Drug Name	Sensitivity (%)
AS	Ampicillin/Sulbactam	93.75
BA	Cotrimoxazole	62.5
CF	Cefotaxime	18.75
RC	Ciprofloxacin	18.75
GF	Gatifloxacin	68.75
AK	Amikacin	100
TE	Tetracycline	93.75
GM	Gentamycin	68.75
TOB	Tobramycin	100
MO	Moxifloxacin	87.5
PR	Caphalexin	93.75
QB	Levofloxacin	62.5
LZ	Linazolid	93.75
CX	Cloxacillin	93.75
AT	Roxithromycin	31.25
LM	Lincomycin	62.5
AZ	Azithromycin	37.5
VA	Vancomycin	100
MU	Mupirocin	93.75
TF	Teicoplanin	86.66
FO	Fosfomycin	100
Cx	Cefoxitin	92.30

The antimicrobial susceptibility pattern of Gram-negative isolates is summarized in [Table 4]. Complete susceptibility was observed for several broad-spectrum agents, including ciprofloxacin, gatifloxacin, ofloxacin, gentamicin, meropenem, aztreonam, imipenem, ertapenem, ceftizoxime, ceftazidime/clavulanic acid and cefepime/tazobactam. Conversely, tetracycline, polymyxin B and piperacillin demonstrated comparatively lower activity against Gram-negative organisms.

Table 4: Sensitivity Percentage of Antibiotics Used for Gram Negative Bacteria (n=12)

Drug Abbreviation	Drug Name	Sensitivity (%)
AS	Ampicillin/Sulbactam	66
BA	Cotrimoxazole	100

CF	Cefotaxime	83.33
PC	Piperacillin	66.66
CH	Chloramphenicol	66.66
RC	Ciprofloxacin	100
GF	Gatifloxacin	100
ZN	Ofloxacin	100
AK	Amikacin	83.33
TE	Tetracycline	33.33
CI	Ceftizoxime	100
GM	Gentamycin	100
MP	Meropenem	100
PT	Piperacillin/Tazobactam	83.33
CM	Cefoperazone/Sulbactam	83.33
CG	Cefpirome	83.33
AC	Aztreonam	100
NT	Netilmicin	66.66
TT	Ticarcillin/Clavulanic acid	100
PB	Polymyxin B	50
IPM	Imipenem	100
CAC	Ceftazidime/Clavulanic acid	100
CAZ	Ceftazidime	83.33
TOB	Tobramycin	83.33
MO	Moxifloxacin	100
EPT	Ertapenem	100
CPT	Cefepime/Tazobactam	100
CL	Colistin	5

As illustrated in [Table 5], Pseudomonas spp. exhibited excellent susceptibility to meropenem, piperacillin/tazobactam and aztreonam (100% each). Moderate susceptibility was observed for fluoroquinolones, imipenem and cefepime/tazobactam (66.7%), whereas cefpirome showed the lowest activity (16.7%) against Pseudomonas isolates.

Table 5: Antibiotic Sensitivity Percentage (%) of Pseudomonas spp. (n=6)

Drug Abbreviation	Drug Name	Sensitivity (%)
PC	Piperacillin	50
RC	Ciprofloxacin	66.66
GF	Gatifloxacin	66.66
ZN	Ofloxacin	66.66
AK	Amikacin	50
GM	Gentamycin	50
MP	Meropenem	100
PT	Piperacillin/Tazobactam	100
CM	Cefoperazone/Sulbactam	50
CG	Cefpirome	16.66
AC	Aztreonam	100
NT	Netilmicin	50
TT	Ticarcillin/Clavulanic acid	50
PB	Polymyxin B	66.66
IPM	Imipenem	66.66
CAC	Ceftazidime/Clavulanic acid	50
CAZ	Ceftazidime	50
TOB	Tobramycin	50
MO	Moxifloxacin	66.66
CPT	Cefepime/Tazobactam	66.66
CL	Colistin	83.3

DISCUSSION

Endophthalmitis is a vision-threatening intraocular infection in which rapid microbiological diagnosis remains fundamental for initiating appropriate antimicrobial therapy and improving visual outcomes. However, the spectrum of causative organisms and their antimicrobial susceptibility patterns varies considerably according to geographical location, clinical setting, and underlying etiology. Therefore, periodic evaluation of local microbiological trends is essential for optimizing empirical antimicrobial therapy. The present study evaluated microbial growth using resin-based automated culture media and characterized the antimicrobial susceptibility profile of bacterial isolates recovered from clinically suspected cases of endophthalmitis.

The overall culture positivity in the present study was 30%, with microbial growth detected in 30 of 100 clinically suspected cases. Although this yield was lower than those reported by Baig et al,[15] (52.5%), Bhavani et al,[16] (46.2%) and Melo et al,[17] (42%), it was comparable with several contemporary studies evaluating routine microbiological diagnosis of endophthalmitis. The

relatively lower culture yield in the present study may be attributed to prior antimicrobial administration before specimen collection, the small volume of intraocular samples available for culture, or the presence of fastidious organisms that are difficult to recover by conventional microbiological techniques. Milligan et al,[18] demonstrated that pediatric blood culture bottles significantly improved organism recovery compared with conventional culture methods, highlighting the value of automated culture systems for low-volume ocular specimens. Likewise, Bhikoo et al,[19] emphasized that specimen quality and sampling technique are important determinants of microbiological yield in suspected endophthalmitis. These observations support the use of resin-based automated culture media as a practical adjunct for routine laboratory diagnosis while recognizing that culture-negative endophthalmitis continues to remain a significant clinical challenge.

Gram-positive cocci were the predominant isolates (53.3%) in the present study, followed by Gram-negative bacilli (40.0%), while Gram-positive bacilli and fungi each accounted for 3.3% of isolates. Methicillin-sensitive Staphylococcus epidermidis represented the single most common pathogen (30% of culture-positive isolates). These findings are consistent with the reports of Joseph et al,[20] Melo et al,[17] and Bhavani et al,[16] all of whom identified coagulase-negative staphylococci as the predominant causative organisms of infectious endophthalmitis. In contrast, Baig et al,[15] observed a relatively higher proportion of Gram-negative organisms, whereas Samira et al,[21] reported Pseudomonas aeruginosa as the leading isolate in their series. Similarly, Tabatabaei et al,[4] demonstrated considerable variation in the microbial spectrum across different clinical settings despite Staphylococcus epidermidis remaining one of the most frequently isolated organisms. These differences probably reflect variations in referral patterns, patient demographics, underlying causes of endophthalmitis, prior antimicrobial exposure and regional microbial epidemiology rather than true changes in disease biology.

The antimicrobial susceptibility profile of Gram-positive isolates observed in the present study was encouraging. Complete susceptibility was demonstrated for vancomycin, amikacin, tobramycin and fosfomycin, while linezolid, ampicillin-sulbactam, cephalexin, tetracycline and moxifloxacin also retained excellent activity. However, markedly lower susceptibility was observed for ciprofloxacin and cefotaxime, suggesting evolving resistance to some commonly used antimicrobials. Comparable findings have been reported by Previous studies,[15-17] which demonstrated preserved susceptibility of Gram-positive ocular isolates to vancomycin while noting declining susceptibility to older fluoroquinolones and selected β-lactam antibiotics. Samira et al,[21] similarly reported universal susceptibility of Gram-positive isolates to vancomycin, reinforcing its continued role as the empirical intravitreal antibiotic of choice for suspected Gram-positive bacterial endophthalmitis. Collectively, these studies, together with the present findings, indicate that although resistance patterns continue to evolve, vancomycin remains a reliable first-line agent for Gram-positive coverage.

Among Gram-negative isolates, excellent in vitro activity was observed for carbapenems, aminoglycosides and fluoroquinolones, whereas lower susceptibility was noted for tetracycline, polymyxin B and piperacillin. Pseudomonas species, the predominant Gram-negative pathogen in the present study, demonstrated complete susceptibility to meropenem, piperacillin-tazobactam and aztreonam. Similar susceptibility trends have been described by Jindal et al,[22] who reported high susceptibility of Gram-negative isolates to gatifloxacin, ofloxacin, amikacin and ceftazidime in post-traumatic endophthalmitis, although a gradual decline in susceptibility to some routinely used antimicrobial agents was observed over time. Baig et al,[15] and Joseph et al,[20] also reported favourable susceptibility of Gram-negative organisms to aminoglycosides and carbapenems, while emphasizing increasing variability in fluoroquinolone susceptibility across centres. These findings underscore the importance of continuous institutional surveillance because empirical antimicrobial recommendations should be guided by current local susceptibility patterns rather than historical data alone.

The present study provides contemporary microbiological data on clinically suspected endophthalmitis using resin-based automated culture media in a tertiary care setting. The predominance of Gram-positive cocci, particularly Staphylococcus epidermidis, together with the preserved susceptibility of Gram-positive isolates to vancomycin and of Gram-negative isolates to carbapenems and aminoglycosides, supports the continued use of these agents for empirical therapy while awaiting culture and susceptibility results. At the same time, the observed variability in susceptibility to fluoroquinolones and selected β-lactam antibiotics highlights the need for periodic regional surveillance and culture-guided antimicrobial therapy to ensure optimal management of this potentially blinding infection.

CONCLUSION

Resin-based automated culture media provided satisfactory microbiological yield in clinically suspected cases of endophthalmitis and enabled identification of the predominant causative organisms along with their antimicrobial susceptibility patterns. Gram-positive cocci, particularly Staphylococcus epidermidis, were the most frequently isolated pathogens, while

vancomycin demonstrated excellent activity against Gram-positive isolates and carbapenems and aminoglycosides showed high efficacy against Gram-negative organisms. These findings support the continued use of culture-guided antimicrobial therapy and highlight the importance of regular surveillance of local microbial epidemiology and antimicrobial susceptibility patterns to optimize empirical management of endophthalmitis.

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