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Microbial Characteristics and Etiologic Patterns of Endophthalmitis at a Tertiary Referral Center: A Retrospective Cohort Study

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ABSTRACT

Introduction. Endophthalmitis is a serious vision-threatening intraocular infection. Its etiology, microbiologic profile, and antimicrobial resistance patterns vary by region. Understanding local patterns is essential for guiding empiric therapy and improving patient outcomes. Authors of this study aimed to identify the most common etiologies, causative organisms, and resistance patterns of endophthalmitis at a Midwestern tertiary referral center.

Methods. Authors conducted a retrospective chart review of patients diagnosed and treated for infectious endophthalmitis at the University of Kansas between 2008 and 2022. Adult patients with infectious endophthalmitis who underwent vitreous biopsy with microbiologic testing were included. Clinical findings, microbiology results, antimicrobial resistance patterns, empiric treatment regimens, and patient characteristics were collected and analyzed.

Results. A total of 149 patients met the inclusion criteria, of whom 52 had positive microbiologic cultures, yielding 64 microbial isolates. The most common etiologies were endogenous infection (n = 43), postoperative infection (n = 32), infection secondary to corneal ulcer (n = 19), and trauma (n = 14). Among culture-positive cases, most isolates were bacterial (61/64). *Staphylococcus epidermidis* and *Staphylococcus aureus* were the most frequently isolated organisms, accounting for 12 and 8 isolates, respectively. Resistance was most commonly observed to erythromycin (58%) and clindamycin (33%), whereas vancomycin resistance was rare (3%).

Conclusions. Endogenous infection was the most common cause of endophthalmitis in this Midwestern cohort. Regional variation in causative organisms and antimicrobial resistance patterns highlights the importance of local surveillance and tailored empiric treatment strategies to optimize patient outcomes.

INTRODUCTION

Endophthalmitis is a rare but serious vision-threatening intraocular infection.[1] It often presents acutely and can lead to irreversible vision loss or even loss of the eye if not treated promptly.[1,2] Exogenous endophthalmitis results from direct inoculation of microorganisms into the eye and has an overall incidence of approximately 0.07% following intraocular procedures.[3] Endogenous endophthalmitis (EE), in contrast, results from hematogenous spread of systemic infection to the eye.[4] EE strongly is associated with underlying conditions such as cancer, immunosuppression, diabetes, and intravenous drug use.[5] Although EE accounts for only 2% to 8% of all endophthalmitis cases,[6-8] it can progress rapidly and result in severe visual impairment, making prompt identification of causative organisms important for guiding empiric therapy.[9]

The microbiology of endophthalmitis varies by geographic region and mechanism of infection. In East Asian populations, *Klebsiella pneumoniae* is the predominant pathogen, accounting for approximately 60% of cases, largely because of its association with liver abscesses.[10] In Western populations, gram-positive bacteria, gram-negative bacteria, and *Candida albicans* are the most common pathogens, with *Staphylococcus aureus, Streptococcus* species, and *Candida albicans* being particularly prevalent in the United States (U.S.).[11] Previous U.S. studies have reported *Staphylococcus* species in approximately 25% to 35% of EE cases and *Streptococcus* species in 30% to 50% of cases.[12,13]

Regional studies provide valuable insight into local pathogen prevalence and antimicrobial resistance patterns. A study from Indiana identified coagulase-negative *Staphylococcus* species as the most common endophthalmitis isolate (37.5%), followed by *Streptococcus viridans* and *Enterococcus* species.[14] A 2024 national database analysis found that *Staphylococcus aureus*, *Streptococcus* species, and *Candida albicans* were the most common pathogens reported in the Midwest.[12] Similarly, a study from West Virginia identified methicillin-resistant *Staphylococcus aureus* (MRSA) as the leading cause of EE and reported frequent multidrug resistance to clindamycin, daptomycin, and fluoroquinolones.[15]

The purpose of this study was to identify the most common causative organisms of endophthalmitis and describe their antimicrobial susceptibility patterns at a Midwestern tertiary referral center. We also examined empiric treatment regimens and patient characteristics associated with these infections. By characterizing local disease patterns and resistance profiles, we aimed to improve understanding of endophthalmitis in the region and inform future treatment strategies.

METHODS

This retrospective single-cohort chart review was approved by the Institutional Review Board (IRB) at the University of Kansas Medical Center. Clinical data were obtained from the Healthcare Enterprise Repository for Ontological Narration (HERON) for all patients diagnosed with endophthalmitis between 2008 and 2022. The study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[16]

Eligible participants were adults with a documented diagnosis of endophthalmitis who underwent treatment at our institution. Treatments included intravitreal tap and inject, pars plana vitrectomy (PPV), and other surgical interventions (e.g., enucleation or evisceration). Patients treated outside our facility were excluded. Demographic characteristics (age, sex, and comorbidities), microbiologic data (culture results, organisms, and antimicrobial susceptibilities), treatment modalities, and surgical outcomes were collected.

All culture isolates were classified as bacterial or fungal. Antimicrobial resistance patterns were evaluated using institutional susceptibility testing. Descriptive analyses were performed to characterize microbial isolates and antibiotic susceptibility patterns.

RESULTS

The initial HERON search identified 1,255 patients, of whom 149 met the inclusion criteria. The mean age at diagnosis was 61 ± 16.5 years, and 58% were male.

Among the 149 patients, 107 (72%) underwent tap and inject, 19 (13%) underwent PPV, 17 (11%) underwent enucleation or evisceration, and 6 (4%) underwent open-globe repair with intraocular antibiotic administration.

Endogenous infection was the most common etiology, accounting for 43 cases (29%; Table 1). Postoperative endophthalmitis was the second most common etiology (32 cases, 22%), followed by corneal ulcer-associated infection

(19 cases, 13%), trauma (14 cases, 9%), and post-injection infection (13 cases, 9%). Among postoperative cases, cataract surgery was the most common preceding procedure (13/32, 41%), followed by PPV (12/32, 38%) and keratoplasty (7/32, 22%). Chronic, device-related, and suture-related infections each accounted for 6% of cases, while 5% had an unknown etiology and 2% were bleb related.

Among patients with EE, diabetes mellitus was the most common comorbidity, affecting 14 of 43 patients (33%). Hypertension was present in 16% (7/43), and 12% (5/43) had active cancer or were receiving chemotherapy. Overall, 25% (37/149) of all patients had diabetes, 13% (19/149) had a history of cancer, and 5% (8/149) had an immunosuppressive condition or were receiving immunosuppressive therapy.

Table 1. Overview of endophthalmitis etiology from all patients included in the study.

Cause of Endophthalmitis	Number of Patients
Endogenous	43
Post Operative	32
Ulcer	19
Trauma	14
Post-Injection	13
Chronic	9
Suture / Device	9
Unknown	7
Bleb	3
Total:	**149**

Fifty-two patients (35%) had culture-positive biopsies, yielding 64 microbial isolates (Table 2). Most isolates were bacterial (61/64), while *Candida albicans* accounted for two isolates. The most common organisms identified were *Staphylococcus epidermidis* (12/64, 19%), *Staphylococcus aureus* (8/64, 12.5%), *Cutibacterium acnes* (6/64, 9%), and *Enterococcus faecalis* (5/64, 8%). *Staphylococcus epidermidis* was the predominant pathogen in postoperative and injection-related infections. Among endogenous infections, *Enterococcus faecalis* was the most frequently isolated organism (3/15 cultures), followed by *Candida albicans* and *Staphylococcus aureus* (2/15 cultures each).

Antimicrobial susceptibility testing demonstrated notable resistance patterns (Table 3). Erythromycin resistance was most common, occurring in 58% of tested isolates (18/31). Resistance to clindamycin and oxacillin was observed in 33% (10/30) and 33% (8/24) of isolates, respectively. Penicillin resistance was identified in 38% (3/8) of isolates, while 27% (7/26) were resistant to trimethoprim-sulfamethoxazole. All tested isolates were susceptible to gentamicin, linezolid, ceftriaxone, and daptomycin. Vancomycin resistance was identified in only one isolate (3%). Among the 149 patients, 25% (n = 37) had diabetes mellitus, 13% (n = 19) had a history of cancer, and 5% (n = 8) had an immunosuppressive disorder or were receiving immuno-

Table 2. Organisms from culture-positive endophthalmitis cases.

Organisms Confirmed Positive for Infectious Endophthalmitis	TOTAL
Staphylococcus epidermidis	12
Staphylococcus aureus	8
Cutibacterium acnes	6
Enterococcus faecalis	5
Streptococcus pneumoniae	4
Bacillus cereus	3
Streptococcus mitis/oralis	3
Pseudomonas aeruginosa	2
Corynebacterium amycolatum	2
Candida albicans	2
Group G streptococcus	2
Alpha hemolytic streptococci	2
Staphylococcus hominus	2
Streptococcus (CO2 dependent)*	1
Coagulase-negative Staphylococcus	1
Streptococcus salivarius	1
Enterobacter cloacae	1
Streptococcus dysgalactiae	1
Abiotrophia defectiva	1
Staphylococcus lugdunensis	1
Dermabacter hominis	1
Fusarium	1
Staphylococcus capitus	1
Mycobacterium chelonae	1
TOTAL	**64**

*CO2 – Carbon dioxide

suppressive medications.

Table 3. Resistances of antibiotics from performed sensitivity testing.

Antibiotic	Number Resistant	Total Sensitivities Performed
Erythromycin	18	31
Clindamycin	10	30
Vancomycin	1	30
Trimethoprim-Sulfamethoxazole	7	26
Tetracycline	6	25
Oxacillin	8	24
Gentamicin	0	15
Levofloxacin	2	12
Linezolid	0	12
Rifampin	1	11
Penicillin	3	8
Ceftriaxone	0	8
Ampicillin	1	5
Daptomycin	0	5

DISCUSSION

Over the 15-year study period, EE was the most common etiology, accounting for 29% of all endophthalmitis cases treated at our tertiary referral center. This finding differs from national trends, where postoperative exogenous endophthalmitis is the most common cause.[17] The relatively high proportion of EE in our cohort may reflect referral bias inherent to tertiary care centers, which often manage more complex endogenous infections requiring multidisciplinary care. In contrast, routine postoperative endophthalmitis may be managed by community ophthalmologists at the site of the original procedure. As such, our findings may reflect the unique case mix encountered at a tertiary referral center in the Midwest.

In the United States, the organisms most commonly associated with endophthalmitis include *Staphylococcus aureus*, *Streptococcus* species, and *Candida albicans*.[1,12,14,18] Among patients with EE, *Staphylococcus aureus* and *Streptococcus* species typically are the predominant pathogens, whereas *Enterococcus faecalis* is reported less frequently.[12,14,18] For example, a tertiary care center in Indiana identified coagulase-negative *Staphylococcus* species as the most common isolate (37.5%), and another regional EE study reported no cases of *Enterococcus faecalis*.[12,14] In our cohort, *Staphylococcus epidermidis* was the most frequently isolated organism overall, while *Enterococcus faecalis* was the most common pathogen among endogenous cases. This predominance of *Enterococcus faecalis* may reflect regional differences in bloodstream infections, healthcare-associated flora, or patient characteristics. These findings contribute to the growing understanding of regional microbiologic variation in Midwestern populations.

Previous studies have identified intravitreal injections, corneal transplantation, and combined ophthalmic procedures as the intraocular interventions most commonly associated with endophthalmitis. Cataract surgery and intravitreal injections have reported endophthalmitis rates of approximately 0.08% and 0.06%, respectively.[3,19] In our study, cataract surgery and intravitreal injections were the most common preceding procedures, each accounting for 13 cases (9%) of endophthalmitis. Pars plana vitrectomy (8%, n = 12) and penetrating keratoplasty (5%, n = 7) were the next most common antecedent procedures. Although we were unable to calculate procedure-specific incidence rates because total procedural volumes were unavailable, the distribution of procedure-related cases in our cohort was generally consistent with published literature.

Many patients in our study had comorbid conditions that may have increased their susceptibility to endophthalmitis, including diabetes, cancer, and immunosuppression. Previous research has identified hypertension, smoking history, coronary artery disease, diabetes, pulmonary disease, and immunocompromised status as risk factors for endophthalmitis.[20] In our cohort, diabetes was the most prevalent comorbidity (25%), followed by hypertension (20%) and a history of cancer (13%). Differences between our findings and those reported in other studies may reflect regional variation in patient populations; however, larger studies are needed to confirm these observations.

Antimicrobial susceptibility testing revealed high rates of resistance to erythromycin and clindamycin, with emerging resistance to trimethoprim-sulfamethoxazole. In contrast, vancomycin resistance was rare and was observed in only one isolate. All tested isolates were susceptible to gentamicin. Vancomycin, often combined with ceftazidime,

remains a cornerstone of empiric therapy because of its broad coverage of gram-positive organisms.[21] Our findings support the continued use of vancomycin as empiric treatment at our institution. Although gentamicin demonstrated excellent susceptibility profiles in this cohort, additional studies are needed before broader recommendations can be made.

Strengths of this study include its extended study period and comprehensive inclusion of clinically diagnosed endophthalmitis cases treated at a tertiary referral center. Several limitations should be considered. First, the retrospective design and relatively small sample size may limit generalizability. Second, some patients with endophthalmitis may not have met the inclusion criteria, potentially resulting in missed cases. Third, microbiologic culture and susceptibility data were not available for all patients. Finally, this was a single-center study, and multicenter investigations are needed to further characterize regional differences in microbiology and antimicrobial resistance patterns and to determine how these differences may influence treatment guidelines.

CONCLUSIONS

In this Midwestern cohort, EE was the most common etiology, and *Enterococcus faecalis* was the predominant pathogen among endogenous cases. These findings highlight the importance of ongoing regional surveillance to guide empiric treatment strategies. The low rate of vancomycin resistance supports its continued role in empiric therapy at our institution, while the favorable susceptibility profile of gentamicin warrants further investigation. Overall, the microbiologic and antimicrobial resistance patterns observed in this study contribute to a better understanding of endophthalmitis in the Midwest and may help inform future treatment approaches.

ARTICLE INFORMATION

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