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ENDOPHTHALMITIS IN ACEH: ANALYSIS OF MICROBIAL SPECTRUM AND ANTIBIOTIC RESISTANCE

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ABSTRACT

IIntroduction: Endophthalmitis is a rare intraocular infection that may result in severe visual loss if not treated promptly. The causative organisms and their antibiotic resistance patterns vary across regions, yet local data from Aceh, Indonesia, remain scarce. This study aimed to describe the microbial profile and antibiotic susceptibility patterns of endophthalmitis cases treated at a tertiary referral center in Aceh.

Methods: Medical records of endophthalmitis cases managed at dr. Zainoel Abidin General Hospital, Banda Aceh, from January 2021 to December 2024 were retrospectively analyzed. The reviewed variables included patient demographic profiles, predisposing factors, etiological classification, microbiological culture results, and antibiotic susceptibility findings. Identification of microorganisms and assessment of antimicrobial sensitivity were performed using standard laboratory culture procedures in combination with the VITEK 2 Compact system.

Result: A total of 111 eyes with unilateral endophthalmitis were included. Exogenous endophthalmitis was the most common type (95.5%), mainly related to post–cataract surgery (36.0%), ocular trauma (29.7%), and keratitis (27.1%). The mean patient age was 52.7 ± 18.5 years, with male predominance (63%). Positive bacterial cultures were identified in 26 eyes (23.5%), predominantly Gram-negative organisms (65.4%). Pseudomonas aeruginosa was the most frequently isolated pathogen (58.8%). Gentamicin showed the highest overall susceptibility (75.0%), while vancomycin demonstrated complete sensitivity against Gram-positive isolates.

Conclusion Endophthalmitis cases in Aceh are predominantly exogenous and largely caused by Gram-negative bacteria, particularly Pseudomonas aeruginosa. Gentamicin, vancomycin, and ceftazidime remain appropriate options for empirical intravitreal therapy, supported by local microbiological evidence.

Keywords : Endophthalmitis, Microbial Spectrum, Antibiotic Resistance, Pseudomonas aeruginosa, Aceh

Introduction

Endophthalmitis is an uncommon but sight-threatening intraocular infection caused by bacterial or fungal invasion of the vitreous and/or aqueous humour. Although rare, it is considered one of the most devastating ophthalmic emergencies because of its high risk of irreversible vision loss, persistent intraocular inflammation, chronic ocular pain, and late sequelae such as phthisis bulbi.[1,2] The reported incidence of endophthalmitis varies globally, with rates ranging from approximately 0.03% to 0.2% worldwide, while studies from Indonesia have reported an incidence of up to 0.18%.[3] The disease arises either from direct microbial inoculation (exogenous) or hematogenous spread from a systemic focus (endogenous). Exogenous cases predominate, accounting for more than 90% of reported infections, typically following cataract surgery, trauma, or intravitreal injections. Endogenous cases represent a minority, and are associated with systemic conditions such as liver abscess, endocarditis, or indwelling catheters.[1,4] The spectrum of causative pathogens, however, differs considerably across regions. Studies from Europe and North America generally report comparable rates of bacterial and fungal endophthalmitis, with Gram-positive organisms identified more frequently than Gram-negative pathogens.

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In contrast, research from several Asian countries has consistently demonstrated a predominance of Gram-negative bacteria, most notably Klebsiella pneumoniae and Pseudomonas aeruginosa. This geographic variation is thought to be related to differences in underlying systemic conditions, particularly the higher burden of hepatobiliary disease in Asian populations, which may act as an important source of bloodstream infection and subsequent ocular involvement.[5]

Because the distribution of pathogens differs across regions, identifying the causative organism is important when choosing empirical antibiotic therapy. Treatment decisions should be based on local microbial patterns and resistance profiles to ensure effective management. As microbiological data on endophthalmitis from Aceh are currently lacking, this study sought to describe the spectrum of causative organisms and their antibiotic resistance patterns in patients treated at tertiary referral centers in the region.

Methods

This research was conducted using a retrospective descriptive approach. Medical records of patients diagnosed with endophthalmitis at dr. Zainoel Abidin General Hospital (RSUDZA), Banda Aceh, from January 2021 to December 2024 were reviewed. Information extracted included patient age, sex, and the affected eye. Clinical variables such as predisposing conditions, microbiological culture findings, and antibiotic susceptibility results were also documented for analysis.

All patients were diagnosed with endophthalmitis based on clinical findings and a comprehensive ophthalmologic examination performed by an ophthalmologist. Predisposing factors reviewed included ocular surface disease, prior ocular trauma or surgery, diabetes mellitus, and thyroid disease. These conditions may compromise ocular defense mechanisms and increase susceptibility to intraocular infection, with disease severity influenced by both microbial virulence and the host immune response. [6] Based on etiological classification, the types of endophthalmitis identified in this study included traumatic, post–cataract surgery, keratitis-related, endogenous, post-trabeculectomy, and post–intravitreal injection endophthalmitis.

Microbiological evaluation was carried out by the Department of Microbiology at dr. Zainoel Abidin General Hospital (RSUDZA) using samples obtained from intraocular fluid and corneal swabs. Intraocular specimens were directly inoculated into BACTEC blood culture bottles and incubated according to standard protocols, while corneal swabs were first enriched in brain–heart infusion (BHI) broth for at least four hours. After incubation, both sample types were subcultured onto blood agar and MacConkey agar plates and incubated under appropriate conditions. Culture plates were observed for bacterial growth, and isolates were subsequently identified using the VITEK 2 Compact system. Identified organisms were classified as Gram-positive or Gram-negative, with species-level identification reported when available. Antibiotic susceptibility testing was performed for all isolates, and results were recorded as sensitive, intermediate, or resistant.

Ethical clearance for this study was granted by the Health Research Ethics Committee of dr. Zainoel Abidin General Hospital, Banda Aceh (Ethical Approval No. 181/ETIK-RSUDZA/2025; Protocol No. 25-06-206). The study was carried out in accordance with the principles of the Declaration of Helsinki. As the analysis was based on retrospectively collected and anonymized medical records, the requirement for informed consent was waived.

Results

Between January 2021 and December 2024, a total of 111 eyes diagnosed with endophthalmitis were analyzed, all presenting with unilateral involvement. Most cases were identified as exogenous endophthalmitis (106 eyes, 95.5%), while endogenous endophthalmitis accounted for only 5 eyes (4.5%) as shown in the Table 1.

Table 1. Demography and predisposing factors

	Total	n (%)
Number of eyes (%)	111	100%
Age (years)	52.7 ± 18.5	-
Sex (male:female)	70 : 41	63% : 37%
Laterality		
Unilateral	111	100%
Bilateral	0	0%
Types of Endophthalmitis		
Endogenous	5	4,5%
Exogenous :		
Traumatic	33	29,7%
Post Cataract Surgery	41	36, %
Keratitis	30	27,1%
Post Trabeculectomy	1	0,9%
Post Intravitreal Injection	1	0,9%
Predisposing Factors :		
Diabetes mellitus	16	14,4%
Thyroid disease	3	2,7%
Ocular Surface Disease	30	27%
Ocular trauma or previous intraocular surgery	76	68,4%

The mean patient age was 52.7 ± 18.5 years (range 2–84 years), with the highest incidence observed in the prime working-age group (25–54 years, 34.2%), followed by the elderly group (≥65 years, 30.6%) and the mature working-age group (55–64 years, 24.3%). A higher proportion of cases occurred in male patients (70 eyes, 63%) compared to females (41 eyes, 37%), showing a clear male predominance.

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Most cases were classified as exogenous endophthalmitis. Endogenous endophthalmitis accounted for only 5 cases (4.5%). Among exogenous cases, post–cataract surgery endophthalmitis was the most frequent presentation, observed in 41 cases (36.0%), followed by traumatic endophthalmitis in 33 cases (29.7%) and endophthalmitis secondary to keratitis in 30 cases (27.1%). Less common etiologies included endophthalmitis following trabeculectomy and intravitreal injection, each reported in 1 case (0.9%).

History of ocular trauma or previous intraocular surgery represented the most common etiology, observed in 76 cases (68,4%), highlighting the predominance of exogenous infections secondary to direct barrier disruption. Ocular surface disease (OSD) was documented in 30 cases (27%), highlighting its role in disrupting the epithelial barrier and facilitating microbial entry. Systemic comorbidities were observed less often, with diabetes mellitus identified in 16 cases (14.4%) and thyroid disease in 3 cases (2.7%). All patients in the thyroid disease group had hyperthyroid conditions, including thyrotoxicosis related to toxic solitary thyroid nodules. Overall, these results indicate that trauma and surgery-related factors were the predominant contributors in this study, while ocular surface disorders and systemic diseases played a secondary role.

Bacterial isolates were identified in 26 eyes (23.5%), comprising 17 Gram-negative and 9 Gram-positive organisms (Table 2). Negative culture results were observed in 40 eyes (36%), while microbiological examinations were not performed in 45 eyes (40.5%). Among cases with bacterial growth, Gram-negative organisms were identified more frequently (65.4%) than Gram-positive organisms (34.6%). Pseudomonas aeruginosa was the most common Gram-negative isolate, accounting for 10 cases (58.8%), followed by Klebsiella pneumoniae (2 cases, 11.8%) and unidentified Gram-negative rods (2 cases, 11.8%). In contrast, Gram-positive isolates were dominated by unidentified Gram-positive rods (4 cases, 44.4%), with individual Staphylococcus species each identified in a single case.

Overall analysis of antibiotic susceptibility showed that gentamicin exhibited the highest level of activity among all tested agents. The overall sensitivity rate was 75.0% (95% CI 42.8–94.5), with comparable effectiveness observed against both Gram-positive bacteria (80.0%, 95% CI 28.4–99.5) and Gram-negative bacteria (71.4%, 95% CI 35.9–91.8). Among Gram-positive isolates, both tetracycline and vancomycin showed complete sensitivity (100%) (95% CI 47.8–100), whereas cefazolin and ceftazidime demonstrated no sensitivity. For Gram-negative bacteria, gentamicin remained the most effective agent, followed by levofloxacin with moderate sensitivity (50.0%, 95% CI 18.7–81.3), while ceftazidime exhibited limited activity (28.6%, 95% CI 8.2–64.1). It should be noted that bacterial isolates were identified in only 26 of 111 eyes, contributing to the wide confidence intervals observed across several antibiotics (Table 3).

Table 2. Distribution of bacterial isolates

Variables	Frequency	(%)
Gram-positive bacteria		
Gram-positive rods (unspecified)	4	3,6%
Staphylococcus epidermidis	1	0,9%
Staphylococcus hominis	1	0,9%
Staphylococcus lugdunensis	1	0,9%
Staphylococcus pseudintermedius	1	0,9%
Staphylococcus warneri	1	0,9%
Gram-negative bacteria		
Gram-negative rods (unspecified)	2	1,8%
Achromobacter denitrificans	1	0,9%
Acinetobacter baumannii	1	0,9%
Klebsiella pneumoniae	2	1,8%
Pseudomonas aeruginosa	10	9,1%
Pseudomonas putida	1	0,9%
Negative culture results	40	36%
Not examined	45	40,5%

Among the four most common bacterial isolates, gentamicin demonstrated the highest activity against Pseudomonas aeruginosa, with a sensitivity rate of 50% (5/10). In contrast, ceftazidime showed lower susceptibility (10% sensitive, 20% resistant), while levofloxacin exhibited limited activity against P. aeruginosa (20% sensitive, 30% resistant). Klebsiella pneumoniae showed complete susceptibility to levofloxacin, with 100% (2/2) of tested isolates sensitive. No susceptibility data were available for ciprofloxacin, cefazolin, tetracycline, or vancomycin against the four most common isolates due to incomplete testing. Susceptibility data for unspecified Gram-negative and Gram-positive rods were similarly limited. Overall, gentamicin and levofloxacin emerged as the most active agents against P. aeruginosa and K. pneumoniae, respectively, within the constraints of available testing (Table 4).

The distribution of bacterial isolates according to the type of endophthalmitis is presented in Table 5. Post–cataract surgery endophthalmitis showed the greatest diversity of isolates and was predominantly associated with Gram-negative bacteria, with Pseudomonas aeruginosa being the most frequently identified organism. P. aeruginosa was also commonly isolated in traumatic endophthalmitis and cases secondary to keratitis. Endogenous endophthalmitis was rare and represented by a single isolate of Klebsiella pneumoniae, while no isolates were identified in post-trabeculectomy or post-intravitreal injection cases.

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Table 3. Antibiotic sensitivity of all bacterial species, Gram positive and Gram negative isolated from endophthalmitis[a]

Antibiotics	All Bacteria			Gram positive			Gram Negative		
	n	S	R	n	S	R	n	S	R
Gentamicin	12	75% (42,8-94,5)	25% (5,5-57,2)	5	80% (28,4-99,5)	20% (0,5-71,6)	7	71,4% (35,9-91,8)	28,6% (8,2-64,1)
Ciprofloxacin	5	60% (14,7-94,7)	40% (5,3-85,3)	5	60% (14,7-94,7)	40% (5,3-85,3)	-	-	-
Ceftazidime	11	18,2% (3,2-52,2)	54,5% (28,0-78,7)	4	0 (0 -60,2)	100% (39,8-100)	7	28,6% (8,2-64,1)	28,6% (8,2-64,1)
Cefazolin	4	0 (0-60,2)	100% (39,8-100)	4	0 (0,-60,2)	100% (39,8-100)	-	-	-
Levofloxacin	15	46,7% (21,3-73,4)	53,3% (26,6-78,7)	5	40% (5.3–85.3)	60% (14.7–94.7)	10	50% (18,7-81,3)	50% (18,7-81,3)
Tetracycline	5	100% (47,8-100)	0 (0-52,2)	5	100% (47,8-100)	0 (0-52,2)	-	-	-
Vancomycin	5	100% (47,8-100)	0 (0-52,2)	5	100% (47,8-100)	0 (0-52,2)	-	-	-

[a]n, sensitive + intermediate + resistant; S, sensitive in% (95% CI) ; R,resistant in% (95% CI). Not all isolated were tested for all the antibiotics mentioned.
[b]"-", not available

Table 4. Antibiotic sensitivity of four most common bacteria isolated from endophthalmitis[a]

Antibiotics	*Pseudomonas aeruginosa*		*Unspecified Gram Negative Rods*		*Klebsiella Pneumonia*		*Unspecified Gram Positive Rods*	
	S	R	S	R	S	R	S	R
Gentamicin	5/10 (50%)	-	-	-	-	-	-	-
Ciprofloxacin	-	-	-	-	-	-	-	-
Ceftazidime	1/10 (10%)	2/10 (20%)	-	-	-	-	-	-
Cefazolin	-	-	-	-	-	-	-	-
Levofloxacin	2/10 (20%)	3/10 (30%)	-	-	2/2 (100%)	-	-	-
Tetracycline	-	-	-	-	-	-	-	-
Vancomycin	-	-	-	-	-	-	-	-

[a]S, sensitive (%); R, resistant (%); Intermediate not mentioned. Not all isolates were tested for all the antibiotics mentioned.
[b]"–",not available.

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Table 5.Distribution of bacterial isolates according to the type of endophthalmitis

Isolates	Endogenous	Traumatic Endophthalmitis	Post-Cataract Surgery	Keratitis	Post-Trabeculec-tomy	Post-Intravitreal Injection	Total
Gram-positive rods(unspecified)	-	1	3	-	-	-	4
Staphylococcus epidermidis	-	1	-	-	-	-	1
Staphylococcus hominis	-	1	-	-	-	-	1
Staphylococcus lugdunensis	-	1	-	-	-	-	1
Staphylococcus pseudintermedius	-	-	1	-	-	-	1
Staphylococcus warneri	-	-	1	-	-	-	1
Gram-negative rods (unspecified)	-	-	1	1	-	-	2
Achromobacter denitrificans	-	-	1	-	-	-	1
Acinetobacter baumannii	-	-	1	-	-	-	1
Klebsiella pneumoniae	1	-	1	-	-	-	2
Pseudomonas aeruginosa	-	2	5	3	-	-	10
Pseudomonas putida	-	-	1	-	-	-	1
Total	1	6	15	4	0	0	26

DISCUSSION

Endophthalmitis is a severe intraocular infection caused by microorganisms entering the eye through external exposure or hematogenous spread. Accurate identification of the causative organism and its growth characteristics plays a key role in the effective management of endophthalmitis. Early diagnosis followed by timely treatment is critical to prevent irreversible visual loss.[7] The microbiological spectrum of endophthalmitis differs depending on clinical setting and geographic location, making knowledge of local pathogen patterns particularly important when selecting empirical therapy. Assessment of regional antimicrobial susceptibility profiles therefore remains essential. At the same time, widespread and often prophylactic use of antibiotics has been associated with the emergence of resistant organisms, underscoring the need for judicious antibiotic use and ongoing microbiological surveillance.[8]

Information on the bacterial organisms causing endophthalmitis in Indonesia, along with their patterns of antibiotic susceptibility, is still scarce. The present study provides an overview of the bacterial spectrum and resistance profiles identified in patients with endophthalmitis managed at a tertiary healthcarel center in Aceh, Indonesia. These findings provide relevant local microbiological data that may help guide empirical antimicrobial therapy and support improved clinical decision-making in the management of infectious endophthalmitis.

In this study, culture-negative results were observed in 36%, whereas culture-positive findings were identified in 23.5%. This predominance of culture-negative cases is consistent with previous reports by Singh et al., with culture negativity rates of up to 60–70% in suspected endophthalmitis, particularly in chronic or partially treated infections[9], while Lee et al. observed that 70% of endophthalmitis cases were culture-negative in a large series of intravitreal injections.[10] Further noted that several factors have been proposed to explain the low culture yield, including prior antibiotic exposure, low microbial load, limited intraocular sample volume, and the use of topical anesthetics, all of which may inhibit bacterial growth and reduce microbiological detection.[9,11]

In the present study, of the 66 eyes that underwent microbiological testing, most specimens were obtained from aqueous humor, with only 8 samples derived from vitreous fluid, which may have further contributed to the low culture yield observed. This is supported by findings from Chiquet et al., who demonstrated that the sensitivity of direct culture methods ranges from 45–70%, with higher sensitivity for vitreous fluid (40–69%) compared with aqueous humor (22–38%).[12] Together, these methodological considerations provide a plausible explanation for the predominance of culture-negative results in our study.

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Pseudomonas aeruginosa was the most frequently isolated pathogen in this study, accounting for 58.8% of cases, which is consistent with findings reported by Lin et al. in China (23–54.6%) and Yospaiboon et al. in Thailand (24.3%), where Pseudomonas species were among the most common Gram-negative organisms causing endophthalmitis.[13,14]

In our study, Pseudomonas aeruginosa predominated and was closely associated with post–cataract surgery, the most common predisposing factor (36%). Similarly, Yap et al. reported cataract surgery as the leading predisposing factor, accounting for 30.1% of cases. [15] The second most common isolates were unspecified Gram-positive rods (44.4%), also predominantly associated with post–cataract surgery, consistent with findings by Chiquet et al. and large series such as the Endophthalmitis Vitrectomy Study (EVS) and the French Institutional Endophthalmitis Study (FRIENDS), which reported Gram-positive bacteria in up to 94% of acute post–cataract endophthalmitis cases.[12]

Traumatic endophthalmitis was the second most common type in our study, accounting for 29.7% of cases. This finding aligns with reports by Li et al., who identified post-traumatic endophthalmitis as the predominant form in China, while noting that postoperative endophthalmitis is more common outside China, an epidemiological pattern also observed in our study. Evidence from previous studies supports the prominent role of ocular trauma in the development of endophthalmitis. Lin et al. reported that trauma accounted for 41.7% of culture-confirmed Pseudomonas aeruginosa endophthalmitis cases, whereas postoperative infections comprised 13.9%. In a larger series, Duan et al. reviewed 330 cases of infectious endophthalmitis and found that post-traumatic causes were most common (58.5%), followed by postoperative cases (20.3%). Taken together, these reports indicate that trauma remains a leading cause of endophthalmitis, while postoperative infection continues to represent a substantial proportion of cases across different regions..[13,16,17]

In this study, antibiotic susceptibility patterns varied between Gram-negative and Gram-positive organisms. Gentamicin showed the most consistent in vitro effectiveness, with an overall sensitivity rate of 75%, including 71.4% among Gram-negative isolates and 80% among Gram-positive isolates. Although these findings indicate favorable antimicrobial activity, the clinical use of aminoglycosides such as gentamicin and amikacin has become less common because of concerns regarding retinal toxicity, including macular ischemia and infarction. As a result, intravitreal aminoglycosides should be administered with caution and considered primarily in selected situations, such as in patients with confirmed penicillin allergy, where intravitreal amikacin may serve as an alternative option.[18,19] Despite these concerns, gentamicin continues to be commonly prescribed in Indonesia, particularly in resource-limited and rural areas, owing to its low cost and wide availability. In the present study, gentamicin demonstrated moderate effectiveness against Pseudomonas aeruginosa (50%) and complete activity against Klebsiella pneumoniae (100%), both of which were among the most frequently isolated pathogens.[11]

Within this framework, ceftazidime and vancomycin continue to serve as the mainstay of empiric intravitreal treatment for endophthalmitis. In the present study, ceftazidime showed relatively low in vitro sensitivity (18.2%); however, it remains widely favored for Gram-negative coverage because of its established retinal safety. This finding differs from the report by Baig et al., who observed high susceptibility of Gram-negative isolates to ceftazidime (91.8%). By comparison, vancomycin demonstrated complete effectiveness against Gram-positive organisms in our cohort (100% sensitivity), consistent with results reported by Baig et al. and Liu et al., who noted sensitivities of 100% and 99.6%, respectively. Taken together, these findings reinforce the continued role of combined intravitreal therapy with vancomycin and ceftazidime to achieve broad antimicrobial coverage in the management of endophthalmitis, despite regional variations in susceptibility patterns.[19–21]

In this study, fluoroquinolones such as ciprofloxacin and levofloxacin showed inconsistent in vitro activity. Ciprofloxacin demonstrated moderate susceptibility confined to Gram-positive isolates (60%), whereas levofloxacin exhibited an overall sensitivity of 46.7%, with comparable activity against Gram-positive (40%) and Gram-negative (50%) organisms. In Indonesia, Lutfiamida et al. reported higher susceptibility rates, with ciprofloxacin sensitive in 73.3% of isolates and levofloxacin in 66.7%, findings that are broadly comparable to but slightly higher than those observed in our study. In contrast, studies from China by Liu et al. demonstrated markedly higher susceptibility, with ciprofloxacin showing 64.7% sensitivity in Gram-positive and 93.5% in Gram-negative isolates, while levofloxacin exhibited 82.3% and 95.8% sensitivity, respectively; similarly, Lin et al. reported 100% susceptibility of Pseudomonas aeruginosa to both ciprofloxacin and levofloxacin. Accordingly, fluoroquinolones continue to be commonly selected as empirical therapy in Indonesia owing to their broad-spectrum activity and ready clinical availability. [11,13,21]

In this study, cefazolin showed no in vitro activity, with 100% resistance among Gram-positive isolates, indicating a minimal role in endophthalmitis management. Although tetracycline demonstrated complete in vitro susceptibility (100%), it is not routinely recommended for endophthalmitis, as current guidelines prioritize intravitreal antibiotics with proven clinical efficacy. Moreover, tetracycline has been associated with reductions in intraocular pressure, and anaerobic bacteria frequently exhibit resistance to cefazolin, further limiting their utility. Accordingly, neither cefazolin nor tetracycline was used for the treatment of endophthalmitis in our study.[19]

CONCLUSION

Endophthalmitis in our study was predominantly caused by Gram-negative organisms, with Pseudomonas aeruginosa emerging as the most frequently isolated pathogen across traumatic, keratitis-related, and postoperative cases. Gentamicin demonstrated high in vitro activity, while ceftazidime and vancomycin remain the mainstay of empirical intravitreal therapy, providing broad Gram-negative and Gram-positive coverage, respectively, despite variable susceptibility observed in vitro. Fluoroquinolones showed inconsistent susceptibility but continue to be commonly used as adjunctive or prophylactic agents because of their broad-spectrum activity and clinical availability. Although limited by retrospective design and low culture yield, this study provides important local microbiological and susceptibility data to support informed management of infectious endophthalmitis.

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