Clinical Ophthalmology

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Two-Decade Retrospective Analysis of Postoperative Endophthalmitis at a Tertiary Care Academic Center: Microbial Spectrum, Treatment Modalities, and Visual Outcomes

Thanaporn Kritfuangfoo[1,2], Ratima Chokchaitanasin[2,3], Tharikarn Sujirakul[2], Thitiporn Thongborisuth[2], Boontip Tipsuriyaporn[2]

[1]Department of Ophthalmology, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand; [2]Department of Ophthalmology, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand; [3]Ophthalmology Unit, Wanon Niwat Hospital, Sakon Nakhon, Thailand

Correspondence: Boontip Tipsuriyaporn, Department of Ophthalmology, Faculty of Medicine Ramathibodi Hospital,Mahidol University, Bangkok, Thailand, 270 Rama VI Road Ratchathewi, Bangkok, 10400, Thailand, Email b.tipsuriyaporn@gmail.com

Purpose: To determine the causative microorganisms, treatment modalities, visual outcomes, and factors influencing the results of postoperative endophthalmitis at a major tertiary referral eye care facility in Thailand.

Patients and Methods: A retrospective review was conducted on patients diagnosed with postoperative endophthalmitis over a 20-year period. The collected data included demographic characteristics, endophthalmitis classification, causative organisms, treatment modalities, and final visual acuity. Factors associated with improved visual outcomes were explored.

Results: This study included 163 eyes (163 patients). Eighty-seven cases (53.4%) were acute-onset, while the rest were delayed-onset. Cataract surgery was the most common prior intraocular procedure. Microorganisms were identified by culture in 29.4% of cases. Coagulase-negative *Staphylococcus* species were predominant among acute-onset cases (57.7%), followed by *Enterococcus faecalis* (15.4%); coagulase-negative *Staphylococcus* species also were predominant among delayed-onset cases (18.9%). The most common treatment was immediate pars plana vitrectomy (PPV) with intravitreal injection. Significant improvements in visual acuity (VA) were observed in the immediate and delayed PPV groups, with mean improvements of 0.80 logMAR ($p < 0.001$) and 0.87 logMAR ($p = 0.001$), respectively. Globe salvage was achieved in 96.3% of cases, with a median final VA of 20/200. Visual improvement, stability, and deterioration were observed in 61.2%, 11.5%, and 27.4% of cases, respectively. Factors associated with poor visual outcomes were diabetes mellitus ($p=0.019$), visual acuity at initial presentation of 20/200 or worse ($p<0.001$), and delayed-onset postoperative endophthalmitis ($p=0.001$).

Conclusion: Immediate PPV with intravitreal injection remains the most common and effective treatment for postoperative endophthalmitis, achieving significant visual acuity improvement and high rates of globe salvage. Visual outcomes were significantly influenced by diabetes mellitus, poor visual acuity at initial presentation, and delayed-onset endophthalmitis, underscoring the importance of timely and tailored management strategies.

Keywords: infectious pan-uveitis, postoperative, intravitreal injection, vitrectomy, endophthalmitis

Introduction

Postoperative endophthalmitis is a particularly serious complication of ophthalmic surgery. Severe and irreversible visual loss can occur in a large proportion of cases, particularly if diagnosis and proper treatment are delayed. Although culture methods may fail to identify the causative pathogen, clinical signs of disease can be sufficient to recognize this condition and initiate treatment.

The most common types of intraocular surgeries performed worldwide are cataract extraction, glaucoma filtration surgery, pars plana vitrectomy (PPV), and intravitreal injection (IVI). The reported incidence of acute-onset postoperative

Received: 22 April 2025
Accepted: 6 August 2025
Published: 12 August 2025

endophthalmitis ranges from 0.036% to 0.36% of eyes undergoing intraocular surgery.[1–3] Additionally, the incidence of post-injection endophthalmitis is reportedly 0.049%–0.056%.[4]

Since 2000, intraocular surgery underwent substantial changes, such as increased numbers of cataract surgeries and PPVs. Surgical advancements included small clear corneal incision cataract surgery, manual small incision cataract surgery, sutureless small-gauge PPV (instead of 20-gauge PPV), and an exponential increase in the use of intravitreal injections for ophthalmic treatment. These developments may influence the incidence of postoperative endophthalmitis.[5,6]

Categorization helps to predict the causative organism and underlying etiology. According to the Endophthalmitis Vitrectomy Study, acute-onset postoperative endophthalmitis is defined as an infection arising within 6 weeks after surgery. Conversely, delayed-onset postoperative endophthalmitis is defined as an infection occurring more than 6 weeks after surgery.[7]

This study was performed to evaluate the clinical features, causative organisms, treatment modalities, and visual outcomes associated with acute-onset and delayed-onset postoperative endophthalmitis during the past 20 years at a university referral center.

Ramathibodi Hospital, a tertiary referral facility in central Thailand, receives endophthalmitis cases from local and distant areas. This single-center retrospective study focused on postoperative endophthalmitis cases from the surrounding region.

Materials and Methods

This study adhered to the tenets of the Declaration of Helsinki and was approved by the Mahidol University Ethics Committee for Human Research (MURA2023/888). Informed consent was waived due to the retrospective nature of the study. No identifiable patient data or images are included in this publication. A retrospective review was conducted involving the medical records of all patients who received treatment for postoperative endophthalmitis at Ramathibodi Hospital between 2001 and 2022. The study included patients with the following International Classification of Diseases and Related Health Problems-10 codes: H44.0 for purulent endophthalmitis, H44.1 for other endophthalmitis, H45.1 for endophthalmitis in diseases classified elsewhere, H59.8 for other postprocedural disorders of the eye and adnexa, such as keratoplasty-associated endophthalmitis and bleb-associated endophthalmitis, and T89.1 for unspecified procedure complications. Diagnoses of endophthalmitis were based on clinical signs and symptoms, including eye pain, vision loss, eyelid edema, conjunctival hyperemia and chemosis, anterior chamber inflammation (eg, flare, cells, hypopyon, pupillary fibrin membrane), blebitis, vitritis, and vitreous opacity on B-scan ultrasonography. In our study, follow-up was defined as the period from the initial diagnosis of endophthalmitis to at least nine months after treatment. The main outcome measurement was the evaluation at nine months post-treatment; therefore, patients who were lost to follow-up before this timepoint were excluded from the analysis.

For all suspected cases of endophthalmitis, demographic data were recorded; these data included age, sex, underlying diseases, laterality, onset and duration, best-corrected visual acuity (VA) at initial presentation (defined as the VA measured at the patient's first visit to our hospital at the time of endophthalmitis diagnosis) and after recovery, pathogen etiology, type of intraocular surgery and associated complications, culture results, and treatments.

Prior to initiating treatment, vitreous and/or aqueous samples were collected for microbiological analysis in all cases. In patients undergoing intravitreal tapping, undiluted vitreous samples were aspirated using a 23-gauge needle attached to a syringe under aseptic conditions at the operating microscope. For patients treated with PPV, undiluted vitreous specimens were obtained at the start of the procedure before infusion was initiated, using the vitrectomy cutter connected to a sterile syringe or tubing. Standard 20- or 23-gauge systems were used, and all procedures were performed by experienced vitreoretinal surgeons. Collected specimens were immediately submitted for microbiological workup, which included inoculation on blood agar, chocolate agar, Sabouraud dextrose agar, and thioglycollate broth to detect aerobic and anaerobic bacteria and fungi. In some cases, molecular testing using 16S and 18S rRNA gene polymerase chain reaction (PCR) assays were performed to enhance pathogen detection. However, molecular diagnostics were not consistently available during the first five years of the study period due to laboratory limitations. Bacterial detection was performed using primers 27F and 519R, commonly applied for broad-range bacterial identification.[8] For fungi, the internal transcribed spacer (ITS1–ITS2) region was amplified using ITS1 and ITS2 primers, which are widely recommended for broad fungal coverage.[9] Immediate PPV was defined as surgery performed within 24 hours of endophthalmitis diagnosis, whereas delayed PPV was performed more than 24 hours after diagnosis in cases where there was no

clinical improvement or worsening following primary vitreous tapping and antimicrobial injection. In cases of bacterial infection, ceftazidime and vancomycin were prescribed as empiric therapy, whereas amphotericin or voriconazole were administered in cases of fungal infection. Specific treatments for each patient were determined based on culture results.

To facilitate statistical analysis, Snellen VA measurements were converted to logarithm of the minimum angle of resolution (logMAR) values. Poor VA measurements were assigned logMAR values of 2.0, 2.3, 2.5, 2.7, and 3.0 for counting fingers, hand motion, light projection, light perception, and no light perception, respectively. The primary outcome measure was VA assessed at nine months, which was used as the reference point for determining the final visual outcome after endophthalmitis management.[10]

Statistical Analysis

Categorical data (eg, sex, laterality, underlying diseases, prior surgeries, and treatment modalities) are shown as numbers and percentages. Continuous variables are presented as means and standard deviations; for variables with skewed distributions, medians and interquartile ranges (IQRs) are presented. Normally distributed continuous variables were analyzed using t-tests. For skewed distributions, the Mann–Whitney *U*-test was used. Categorical variables were analyzed using the Pearson chi-squared test or Fisher's exact test. Multivariate logistic regression analysis was utilized to identify factors associated with poor visual prognosis. Multilevel linear random intercepts and random slope regression models were used to analyze the mean difference in VA (logMAR) from preoperative to postoperative across the three treatment groups. The models also compared the mean preoperative VA (logMAR) among the treatment groups and accounted for variations between individual participants at the preoperative stage (intercepts). Additionally, the models calculated the mean difference in the effect over time (slopes) on VA (logMAR) between preoperative and postoperative stages across the three groups. Statistical analysis was performed using STATA version 14.0 (Stata Corp LP, College Station, TX, USA). P-values <0.05 were considered statistically significant.

Results

This study initially included 181 patients with suspected endophthalmitis, according to their electronic medical records. After the exclusion of 18 patients (Figure 1) due to incomplete records, altered diagnoses, or loss to follow-up, 163 eyes of 163 patients were analyzed (Table 1). The participants comprised 89 men and 74 women with a mean age of 64.8±13.0 years. Endophthalmitis involved the right eye in 82 cases (50.3%). The two most prevalent underlying diseases were hypertension and diabetes mellitus, observed in 53% and 31% of cases, respectively, as presented in Table 1.

All included patients had postoperative endophthalmitis; 53% of eyes (87 of 163) were acute-onset. The median intervals from surgery to presentation were 8 days (IQR, 3–14) and 730 days (IQR, 125–1753) in the acute and chronic postoperative endophthalmitis groups, respectively. Cataract surgery was the primary procedure associated with the highest incidence of postoperative endophthalmitis (94 cases, 57.7%). Eighteen eyes (11%) received vitreous tapping and intravitreal antibiotics at the referring hospital prior to presentation at our center. Of these, 14 were in the cataract surgery group, 2 in the PPV group, and 1 each in the glaucoma and IVI groups. Among these, 10 cataract cases and all PPV and glaucoma cases were culture negative.

Microbiological investigations of vitreous fluid were performed for all patients prior to treatment. The treatment modalities utilized in this study, including intravitreal or intracameral injections, immediate PPV, delayed PPV, and enucleation, are summarized in Table 2. All PPV procedures were combined with antimicrobial intravitreal injection (IVI). Immediate PPV was the most common approach, employed in 98 eyes (60.1%), followed by vitreous tapping with IVI alone in 50 eyes (30.7%). Delayed PPV was performed in 12 eyes (7.4%) following initial IVI due to clinical deterioration. The mean time to delayed PPV after initial presentation was 3.9 days (range 2–10 days). Intracameral injection was performed in two eyes (1.2%), when the anterior and posterior chambers were considered as a single chamber, either due to prior scleral fixation of an intraocular lens procedure or the aphakic status of the patient.

Additionally, trends in treatment modalities for endophthalmitis from 2001 to present are summarized in Table 2. A shift in management strategies was observed over the years. Immediate PPV became the predominant approach in recent years, particularly after 2016. In contrast, vitreous tapping IVI alone and delayed PPV were more frequently employed in earlier years, especially before 2010.

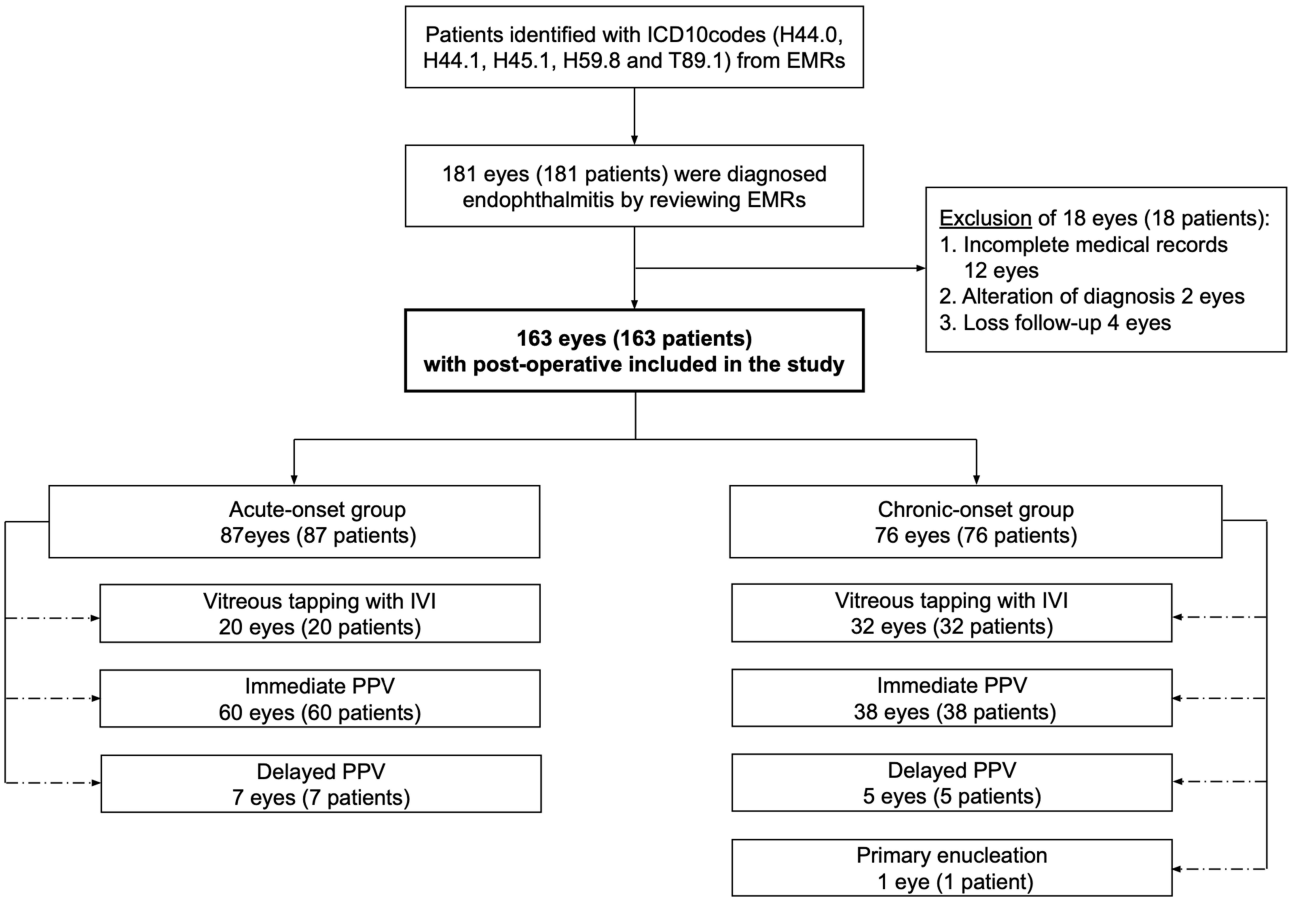

Figure 1 Post-operative endophthalmitis inclusion and subgroup treatment analysis flow diagram.
Notes: Bold text in the diagram indicates the total number of eyes included in the study cohort.
Abbreviations: EMRs, electronic medical records; ICD10, 10th revision of the International Classification of Diseases; IVI, intravitreal injection; PPV, pars plana vitrectomy.

Variations in drug treatment for postoperative endophthalmitis are presented in Table 2. Antimicrobial agents were administered to all patients based on suspected pathogens. The most commonly used intravitreal antibiotic regimens for bacterial infections were combinations of ceftazidime and vancomycin. Among the 163 total cases, 141 (86.5%) received systemic antibiotics, predominantly second- or third-generation fluoroquinolones, administered primarily via the oral route. Furthermore, 33 of 141 cases received intravenous antibiotics, predominantly involving a combination of ceftazidime and vancomycin.

Table 3 presents the preoperative and postoperative VA across the three treatment groups: vitreous tapping with IVI, immediate PPV, and delayed PPV. Two eyes that received intracameral injections were included in the IVI group. The mean initial VA before treatment was 2.0 logMAR in the immediate PPV group and 1.7 logMAR in both the IVI and delayed PPV group. Significant VA improvements were observed in the immediate PPV and delayed PPV groups, with mean improvements of 0.8 logMAR ($p < 0.001$) and 0.9 logMAR ($p = 0.001$), respectively. Multilevel linear regression models with random intercepts and slopes were used to analyze the mean differences in VA changes between treatment groups. The IVI group showed significantly less VA improvement compared to the immediate PPV group (mean difference: 0.6 logMAR, $p < 0.001$) and the delayed PPV group (mean difference: 0.7 logMAR, $p = 0.029$). No statistically significant difference in VA improvement was found between the immediate and delayed PPV groups.

Among acute-onset cases, 60 of 87 eyes (69%) underwent immediate PPV with IVI, whereas in delayed-onset cases, 38 of 76 eyes (50%) underwent the same treatment. One patient with a prior history of corneal transplantation required immediate enucleation due to severe infection. During the follow-up period, five additional eyes required enucleation due to inadequate response to treatment. For patients who retained their eye, the median final VA was 20/200, corresponding to 0.9 (0.3, 2.3) logMAR. VA improved by more than five letters in 61.2% of cases, remained stable in 11.5%, and declined by more than five letters in 27.4%.

Table 1 Demographic Data of 163 Patients with Postoperative Endophthalmitis

Demographic data	(n=163)
Gender (n, %)	
Male	89 (54.6)
Female	74 (45.4)
Mean age of onset (years ± SD)	64.8±13.0
Onset of presentation (n, %) and median interval (days, IQR)	
Acute	87 (53.4), 8 (3–14)
Chronic	76 (46.6), 730 (125–1753)
Laterality (n, %)	
Right	2 (50.3)
Left	81 (49.9)
Underlying disease (n, %)	
Hypertension	87 (53.4)
Diabetes mellitus	50 (30.7)
Immunocompromised	6 (3.7)
Chronic kidney disease	5 (3.1)
Cirrhosis	4 (2.5)
Baseline fundus characteristic (n=149, %)	
Retinitis and/or choroiditis	29 (24.2)
Vasculitis	29 (24.2)
Retinal hemorrhage	16 (13.3)
Retinal detachment	11 (16.5)
Median follow-up time (months, IQR)	63.4 (37.3–90.7)

Abbreviations: IQR, interquartile range; IVI, Intravitreal injection; PPV, Pars plana vitrectomy; SD, standard deviation.

Table 2 Trends in Treatment Modalities and Antimicrobial Agents for Endophthalmitis Across Different Time Periods

Variables	Periods (n, %)			
	Before 2010	2011-2015	After 2016	Total
Ocular related surgeries				
Cataract	39 (41.5)	21 (22.3)	34 (35.1)	94 (57.7)
Filtering surgery	10 (43.5)	5 (21.7)	8 (34.8)	23 (14.1)
PPV	6 (37.5)	4 (25.0)	6 (37.5)	16 (9.8)
Combined cataract and others	2 (16.7)	3 (25.0)	7 (58.3)	12 (7.4)
Corneal transplantation	6 (60.0)	4 (40.0)	-	10 (6.1)
IVI	4 (50.0)	1 (12.5)	3 (37.5)	8 (4.9)
Treatment modalities				
Vitreous tapping with injection[a]	31 (59.6)	18 (34.6)	3 (5.8)	52 (31.9)
Immediate PPV	26 (26.5)	18 (18.4)	54 (55.1)	98 (60.1)
Delayed PPV	10 (83.4)	1 (8.3)	1 (8.3)	12 (7.4)
Direct enucleation	1(0.6)	-	-	1 (0.6)

(*Continued*)

https://doi.org/10.2147/OPTH.S535966

Table 2 (Continued).

Variables	Periods (n, %)			
	Before 2010	2011-2015	After 2016	Total
Drugs				
IVI ceftazidime and vancomycin	62 (40.8)	36 (23.7)	54 (35.5)	152 (93.3)
IVI vancomycin	1 (50.0)	-	1(50.0)	2 (1.2)
IVI ceftazidime, vancomycin and antifungal	-	-	2 (100)	2 (1.2)
IC ceftazidime and/or vancomycin	2 (100)	-	-	2 (1.2)
IC voriconazole	1 (50.0	-	1(50.0)	2 (1.2)
Subconjunctival ceftazidime and vancomycin	1 (100)	-	-	1 (0.6)
Systemic oral antibiotic	55 (39.0)	34 (24.1)	52 (36.9)	141(86.5)
Systemic intravenous antibiotic	10 (30.3)	3 (9.1)	20 (60.6)	33 (20.2)
Systemic antifungal	1 (25.0)	1 (25.0)	2 (50.0)	4 (2.4)

Abbreviations: IVI, Intravitreal injection; IC, Intracameral injection; PPV, Pars plana vitrectomy [a]Injection: Intravitreal injection and intracameral injection in single chamber.

Table 3 Mean VA (Log MAR) Value and Mean Difference of Participants From Initial and Final Visual Acuity of Three Different Treatment Groups

Variables	Treatment Groups			Mean Difference in VA Comparison Between Treatment Group					
	IVI (n=52)	iPPV (n=98)	dPPV (n=12)	IVI vs iPPV	p-value	IVI vs dPPV	p-value	iPPV vs dPPV	p-value
Initial VA(log MAR)	1.7±0.9	2.1±0.6	1.7±0.8	−0.3 (−0.6 to −0.1)	0.008[a]	0.1 (−0.4 to −0.5)	0.973[a]	0.3 (−0.1 to −0.7)	0.087[a]
Final VA(log MAR)	1.5±1.2	1.3±1.1	0.9±1.0						
Mean difference (95% CI, p-value[b]) between initial and final VA	−0.0.2 (−0.5 to 0.1, 0.108)	−0.8 (−1.0 to −0.6, <0.001)	−0.9 (−1.4 to −0.3, 0.001)	−0.6 (−0.9 to −0.3)	<0.001[c]	−0.7 (−1.3 to −0.1)	0.029[c]	−0.1 (−0.7 to −0.6)	0.841[c]

Notes: [a]Multilevel mean difference (multilevel linear regression) random intercepts and random slope regression models were used to compare mean difference in VA value (log MAR) at initial between three groups and between each participant (intercept) at initial.[b]Multilevel mean difference (multilevel linear regression) random intercepts and random slope regression models were used to analyze.
Mean difference in VA value (log MAR) between initial and final in IVI, PPV and delay PPV group.[c]Multilevel mean difference (multilevel linear regression) random intercepts and random slope regression models were used to calculate mean difference in effect over time (slope) on VA (log MAR) at initial and final between three groups.
Abbreviations: IVI, Intravitreal injection; iPPV, Immediate pars plana vitrectomy; dPPV, Delay pars plana vitrectomy; VA, Visual acuity.

Prior Intraocular Surgeries

We analyzed the relationships between prior intraocular surgeries and postoperative endophthalmitis (Table 4). Our results showed that cataract surgery was the most common procedure among the 94 eyes (57.7%) with postoperative endophthalmitis. Within this group, complicated surgeries involving posterior capsular rupture occurred in 12 eyes (12.8%). Other procedures included glaucoma surgeries (trabeculectomy and glaucoma drainage devices) in 23 eyes (14.1%), vitrectomy in 16 eyes (9.8%), corneal transplantation (penetrating keratoplasty and keratoprosthesis implantation) in 10 eyes (6.1%), and IVI in eight eyes (4.9%). Twelve eyes (7.4%) had undergone combined cataract surgery with other procedures, such as vitrectomy and trabeculectomy.

The median age at presentation for patients undergoing glaucoma surgery was 61 years, the lowest among all surgical groups. Conversely, the highest median age at presentation was 70 years, observed in the corneal transplantation group. The interval between surgery and endophthalmitis diagnosis varied among procedures. Most patients with cataract surgery–, combined cataract surgery–, or intravitreal injection–related postoperative endophthalmitis presented with acute disease. Conversely, most patients who underwent prior glaucoma surgeries or corneal transplantation presented with chronic disease.

Table 4 Different Prior Intraocular Surgeries with Their Associated Factors and Visual Outcomes

Variables	Cataract surgeries n=94 (57.7%)	PPV n=16 (9.8%)	Glaucoma Surgeries n=23 (14.1%)	Keratoplasty n=10 (6.1%)	IVI n=8 (4.9%)	Combined Cataract Surgeries n=12 (7.4%)
Age (median, IQR)	69 (41–87)	61.5 (43–75)	61 (5–84)	70 (38–77)	63 (23–80)	63.5 (23–73)
Acute onset (n, %)	60 (63.8%)	8 (50.0%)	2 (9.5%)	–	8 (100%)	9 (75%)
Culture-positive cases (n, %)	25 (26.6%)	4 (25.0%)	12 (52.2%)	4(40.0%)	3 (37.5%)	4 (33.3%)
Acute onset with positive culture (n/N, %)	18/60 (30.0%)	2/8 (25.0%)	1/2 (50.0%)	-	3/8 (37.5%)	3/9 (33.3%)
Delayed-onset with positive culture (n/N, %)	7/34 (20.6%)	2/8 (25.0%)	11/21 (52.4%)	4/10 (40.0%)	-	1/3 (33.3%)
VA logMAR[a] (median, IQR)						
Initial	2.0 (1.3–2.3)	2.0 (1.3–2.3)	2.3 (2.3–2.7)	2.3 (2.0–2.3)	2.2 (1.3–2.3)	2.3 (2.2–2.3)
Final	0.5 (0.2–2.0)	0.5 (0.5–2.3)	2.3 (2.2–3.0)	3.0 (2.0–3.0)	1.5 (0.9–2.0)	1.5 0.3–2.0)
Treatment						
Vitrectomy (n, %)	68 (72.3%)	11 (68.8%)	13 (56.5%)	4 (40.0%)	5 (62.5%)	9 (75.0%)
IVI (n, %)	26 (27.7%)	4 (25.0%)	10 (43.5%)	4 (40.0%)	3 (37.5%)	3 (25.0%)
Globe salvage (n, %)	93 (98.9%)	15 (93.8%)	20 (87.0%)	9 (90.0%)	8(100%)	12 (100%)

Notes: [a]The enucleation eye was excluded from the analysis.
Abbreviations: IVI, Intravitreal injection; PPV, Pars plana vitrectomy.

Furthermore, we examined variations in globe salvage rates across surgical groups. The lowest rate was observed in the prior glaucoma surgery group (87%), whereas the highest rates were observed in the IVI and combined cataract surgery groups (100%). After the exclusion of cases requiring enucleation, the most favorable visual outcomes were achieved in the cataract and vitrectomy groups: median (IQR) VA of 0.5 (0.2–2.0) logMAR and 0.5 (0.5–2.3) logMAR, respectively. In subgroup analysis focusing on cataract surgery, the final median (IQR) VA after endophthalmitis treatment was less favorable in cases involving complicated cataract surgery (1.15 [IQR 0.60–2.15] logMAR) than in non-complicated cases (0.40 [IQR 0.20–2.0] logMAR). However, this difference in VA was not statistically significant (p=0.06). The least favorable visual outcome was observed in the prior corneal transplantation group, with a median (IQR) VA of 3.0 (2.0–3.0) logMAR.

Causative Microorganisms

Positive cultures were obtained in 52 of 163 eyes (31.9%). Bacteria were isolated in 42 eyes (80.7%), fungi were isolated in five eyes (9.6%), multiple bacterial organisms were isolated in one eye (2.0%), and mixed causative organisms in four eyes (7.7%). Notably, seven bacterial infections were identified through 16S rRNA analysis and negative culture methods, whereas two fungal infections were identified through 18S rRNA analysis and negative culture methods. The specific causative organisms, classified according to onset timing, and their visual outcomes are presented in Table 5. When considering the previous surgical procedures, the positive-culture rate was highest in the glaucoma surgery group (52.2%) and lowest in the vitrectomy group (25.0%). In acute postoperative endophthalmitis, positive cultures were obtained in 26 of 87 eyes (29.9%). The most frequently identified microorganism was coagulase-negative *Staphylococcus* (CoNS; 15/26, 57.7%), followed by *Enterococcus faecalis* (4/26, 15.9%).

Among cases of delayed-onset postoperative endophthalmitis, positive cultures were obtained in 22 of 76 eyes (29.0%). CoNS was again the most frequently identified microorganism (4/22, 18.2%). Most culture-positive delayed-onset postoperative endophthalmitis cases were associated with glaucoma surgery (11/21, 52.4%), and *Streptococcus* species were the predominant organisms in three cases. *Pseudomonas aeruginosa* infection was the most virulent organism, causing final VA of no light perception in all three affected patients. *Staphylococcus aureus* and CoNS were comparatively less virulent, with the best median final VA.

https://doi.org/10.2147/OPTH.S535966

Table 5 Culture-Positive Pathogen Results According to Onset, Ocular-Related Surgeries and Visual Acuity

Positive Culture Results (n=52)	Onset (n, %)		Ocular-Related Surgeries (n, %)						Visual Acuity logMAR (mean±SD)		Total
	Acute	Chronic	Cataract	Filtering surgery	PPV	Combined Cataract and Others	Keratoplasty	IVI	Initial	Final	
Gram-positive cocci											
Staphylococcus aureus	2 (40.0)	3 (60.0)	3 (60.0)	1 (20.0)	-	-	1 (20.0)	-	1.8±0.8	0.7±0.7	5 (9.6)
Staphylococcus coagulase negative	15 (83.3)	3 (16.7)	14 (77.8)	1 (5.6)	1 (5.6)	1 (5.6)	-	1 (5.6)	2.0±0.5	1.6±1.1	18 (34.6)
Streptococcus viridans	-	3 (100)	-	2 (66.7)	-	-	1 (33.3)	-	2.3±0.2	2.9±0.1	3 (5.8)
Streptococcus pneumoniae	1 (50.0)	1 (50.0)	1 (50.0)	1 (50.0)	-	-	-	-	2.5±0.2	3.0±0.0	2 (3.8)
Enterococcus faecalis	3 (50.0)	3 (50.0)	1 (16.7)	3 (50.0)	1 (16.7)	1 (16.7)	-	-	2.6±0.1	2.1±0.9	6 (11.6)
Gram-positive bacilli											
Anthrobactor spp	1 (100)	-	-	-	-	1 (100)	-	-	2.3	2.0	1 (2.4)
Gram-negative											
Heamophilus spp.	-	2 (100)	2 (100)	-	-	-	-	-	2.5±0.2	2.0±0.0	2 (3.8)
Klebsella pneumoniae	1 (100)	-	-	-	-	-	-	1 (100)	2.3	2.0	1 (2.4)
Serratia marcescens	-	1 (100)	-	-	-	1 (100)	-	-	2.0	2.7	1 (2.4)
Pseudomonas aeroginosa	1 (33.3)	2 (66.7)	1 (33.3)	2 (66.7)	-	-	-	-	2.6±0.1	3.0±0.0	3 (5.8)
Multiple bacterial organisms	-	1 (100)	-	1 (100)	-	-	-	-	2.7	2.3	1 (2.4)
Fungus											
Penicillium spp.	-	1 (100)	-	-	-	-	1 (100)	-	2.5	3.0	1 (2.4)
Aspergillus spp.	-	3 (100)	1 (33.3)	1 (33.3)	-	-	1 (33.3)	-	2.5±0.3	1.9±0.9	3 (5.8)
Rigidoporus microporus		1 (100)	-	-	1 (100)	-	-	-	2.3	3.0	1 (2.4)
Mixed causative organisms[a]	4 (100)	-	2 (50.0)	-	1 (25.0)	-	-	1 (25.0)	1.8±0.5	1.3±0.8	4 (7.6)
Total	28 (53.8)	24 (46.2)	25 (44.2)	12 (23.1)	4 (9.6)	4 (5.8)	4 (7.7)	3 (9.6)	2.2±0.6	1.6±1.1	52 (100)

Note: [a]Mixed causative organisms are classified as bacterial and fungal organisms.
Abbreviations: IVI, Intravitreal injection; PPV, Pars plana vitrectomy.

Among five eyes with culture-proven fungal endophthalmitis, three were infected with *Aspergillus* spp., one with *Penicillium*, and one with *Rigidoporus*. Based on initial treatment modality, one eye received IVI (amphotericin and voriconazole) without vitrectomy and achieved successful infection control (*Penicillium*). Two eyes underwent immediate PPV (*Aspergillus*) and both were successfully salvaged. The remaining two eyes received only IVI as delayed PPV was not feasible due to uncontrolled infection and poor corneal clarity; both subsequently required enucleation (*Aspergillus* and *Rigidoporus*). The remaining three cases with preserved eyes, the median VA was 2.4 logMAR. All fungal infection cases exhibited delayed onset, with mean and median intervals from surgery (two keratoprostheses, one trabeculectomy, one phacoemulsification, and one scleral fixation of an intraocular lens) to diagnosis of 96.6 and 56.4 weeks, respectively.

Subsequently, participants were categorized into two groups based on visual outcomes, as determined by the median final VA (Table 6). These groups had VA better than 20/200 and VA equal to or less than 20/200; six enucleation cases were excluded from the analysis. Univariate analysis revealed that diabetes mellitus, initial VA of 20/200 or worse, hypopyon at initial presentation, and delayed-onset postoperative endophthalmitis were factors significantly associated

Table 6 Factors Associated with Final Visual Outcome After Treatment of Postoperative Endophthalmitis by Univariate and Multivariate Analysis (Enucleation Eyes Were Excluded)

Factors	Good visual Outcome (n/N, %)	Univariate		Multivariate	
		OR (95% CI)	p-value	OR (95% CI)	p-value
Gender					
Male	38/86 (44.2)	1.7 (0.92, 3.3)	0.092		
Female	41/71 (57.8)				
Underlying disease					
Diabetes mellitus					
Present	18/48 (37.5)	2.4 (1.2, 5.1)	0.019	2.7 (1.2, 5.9)	0.019
Absent	61/109 (56.0)				
Immunocompromised					
Present	3/4 (75)	0.3 (0.0, 3.2)	0.34		
Absent	76/153 (49.7)				
Chronic kidney disease					
Present	2/5 (40.0)	1.5 (0.3, 9.5)	0.641		
Absent	77/152 (50.7)				
Initial visual acuity					
<20/200	24/26 (92.3)	16.6 (3.8, 73.1)	<0.001	35.9 (7.2, 179.9)	<0.001
≥20/200	255/131 (42.0)				
Onset					
Delayed	30/72 (41.7)	1.9 (1.0, 3.6)	0.047	3.9 (1.8, 8.5)	000
Acute	49/85 (57.7)				
Hypopyon					
Present	29/73 (39.7)	2.3 (1.1, 4.4)	0.019	0.9 (0.5, 2.0)	0.951
Absent	49/84 (58.3)				
Culture					
Positive	23/48 (47.9)	1.2 (0.6, 2.3)	0.69		
Negative	56/109 (51.4)				
Treatment by vitrectomy					
Performed	55/105 (52.4)	1.6 (0.6, 2.8)	0.46		
Not performed	24/52 (46.2)				

https://doi.org/10.2147/OPTH.S535966

with poor visual outcomes. No significant differences in visual outcomes were observed based on other factors, such as sex, immunocompetence, end-stage renal disease status, culture results, and vitrectomy status. Stepwise logistic regression analysis confirmed significant associations of poor visual outcomes with diabetes mellitus (odds ratio [OR]=2.65; 95% confidence interval [CI], 1.17–5.96), VA at initial presentation of 20/200 or worse (OR=35.87; 95% CI, 7.15–179.89), and delayed-onset postoperative endophthalmitis (OR=3.9; 95% CI, 1.79–8.50).

In this study, six patients underwent enucleation due to uncontrolled infection after treatment, representing a globe salvage rate of 96.3%. The infections occurred after three postoperative trabeculectomies, one phacoemulsification, one vitrectomy with scleral fixation, and one keratoprosthesis implantation.

Discussion

In cases of postoperative endophthalmitis, intraocular fluid smears and cultures remain the gold standard for identifying causative organisms. The culture-positive rate in our study was lower than typically reported in the literature, where postoperative endophthalmitis culture yields generally range from 40% to 70%.[11–13] Several factors may explain this finding. Eighteen eyes (11%) had received intravitreal antibiotics prior to referral, potentially suppressing organism growth by the time of sample collection. Additionally, limited vitreous volume in some cases and the use of conventional culture methods without molecular diagnostics could have reduced detection sensitivity. Culture-positive rates also varied by prior surgery type, with higher rates in the glaucoma group and lower rates in the cataract and PPV groups. This may be partly due to pre-referral treatment: 14 of the 18 pretreated eyes were in the cataract group (10 culture-negative), and all pretreated PPV and glaucoma cases were also culture-negative. Differences in sample size across surgical subgroups may also have contributed to the variability in culture positivity.

The Endophthalmitis Vitrectomy Study (1995) showed that early vitrectomy significantly improved outcomes in patients with light perception vision, with a threefold greater chance of achieving 20/40 vision.[14] Since then, advances in surgical techniques have increased the success of PPV, which has become more widely adopted in managing endophthalmitis.[5] The Complete and Early Vitrectomy for Endophthalmitis (CEVE) approach is now recommended as a primary treatment, especially when the fundus view is obscured or macular involvement cannot be excluded.[15] We compared VA at initial presentation among three groups: IVI alone, immediate PPV with IVI, and delayed PPV with IVI. Initial VA was generally better in the IVI and delayed PPV groups, likely reflecting clinical decisions to reserve immediate PPV for eyes with more severe vitritis.

Post-treatment outcomes showed significant visual improvement in both the immediate and delayed PPV groups, while the IVI group showed no significant change. Visual improvement was also significantly greater in the PPV groups compared to the IVI group. These findings suggest that PPV—whether performed initially or after IVI—offers superior visual outcomes, particularly in patients with poor baseline vision or severe vitritis. This aligns with previous studies reporting that immediate PPV results in better visual outcomes compared to IVI alone in cases of postoperative endophthalmitis presenting with poor vision or severe vitritis.[15,16]

The limited improvement in the IVI group may be due to the absence of mechanical clearance of infectious and inflammatory material. Additionally, less severe initial presentations in this group may have led to smaller observed gains in visual acuity. The difference in outcomes between immediate and delayed PPV was not statistically significant, likely due to the small sample size in the delayed PPV group. These findings underscore the need for individualized treatment based on disease severity, with close monitoring to allow timely surgical intervention when needed.

Intravitreal antibiotics are essential for initial management of postoperative endophthalmitis and are often combined with topical and systemic agents. Vancomycin and ceftazidime are commonly used due to their broad-spectrum coverage. Vancomycin targets gram-positive bacteria, including methicillin-resistant strains, while ceftazidime is preferred for gram-negative coverage and is safer than amikacin.[17] The use of topical and systemic antibiotics alongside intravitreal therapy in postoperative endophthalmitis depends on disease severity and patient factors. The EVS recommends systemic antibiotics in cases with severe presentation, such as dense hypopyon or poor initial vision. The 2013 ESCRS guidelines also advise that if systemic antibiotics are used for severe acute-onset cases, they should align with the spectrum of intravitreal agents.[18] In our study, systemic antibiotics were used in 87% of cases, primarily via oral administration. Intravenous antibiotics were given in 20%, typically for more severe presentations. While intravenous antibiotics may be

perceived as beneficial in advanced cases, their efficacy remains uncertain, especially in milder disease, as existing studies have not shown a clear advantage.

Cataract surgery was the most common procedure among the 94 eyes with endophthalmitis. Previous studies have identified posterior capsule rupture as a significant risk factor for post-cataract endophthalmitis.[13,19–26] In our study, we were unable to calculate the true incidence of posterior capsule rupture; therefore, we could not analyze its relationship with endophthalmitis. Of the 94 cataract cases, 82 (87.2%) were uncomplicated and 12 (12.8%) were complicated. Final median VA was poorer in the complicated group (1.15 logMAR) compared to the uncomplicated group (0.40 logMAR), though this difference was not statistically significant.

In our cohort, the median time from surgery to presentation in the chronic group was 730 days, which is longer than the typical duration of two to three months but remains plausible given that delayed-onset chronic endophthalmitis can present months to years after surgery. These indolent cases may remain subclinical for prolonged periods before eventually manifesting with signs of inflammation, as described in previous reports.[27–29] The timing of endophthalmitis onset varied by procedure. Acute-onset cases were more common after cataract surgery, combined cataract procedures, and IVI, while delayed-onset cases occurred more frequently after glaucoma surgery or corneal transplantation. Our findings align with prior reports indicating that bleb-associated endophthalmitis occurs in 0.2% to 9.6% of glaucoma filtering surgeries, typically presenting more than one month postoperatively.[30–32] Delayed-onset cases often have poor outcomes despite infection control and 22% requiring enucleation or evisceration.[30,32]

Our study included 10 cases of delayed-onset post-keratoplasty endophthalmitis, with one requiring enucleation. The remaining cases had a median final VA of 3.0 logMAR, reflecting poor outcomes. Similarly, Tran et al reported unfavorable visual outcomes in patients with delayed-onset endophthalmitis following penetrating keratoplasty.[33]

In this study, the spectrum of endophthalmitis isolates predominantly comprised gram-positive microorganisms, such as CoNS (*Staphylococcus epidermidis), E. faecalis* and *Staphylococcus aureus*. In culture-positive acute-onset cases, CoNS was the most common isolate (57.7%). This aligns with their known role as common skin and ocular surface flora, which may be introduced during intraocular procedures. Although consistent with prior studies,[34–36] our data underscore the continued predominance of CoNS in postoperative endophthalmitis and highlight the need for meticulous perioperative aseptic precautions to minimize contamination risk.

Delayed-onset postoperative endophthalmitis is typically caused by *Propionibacterium* spp., CoNS, and fungi.[37–39] In the present study, CoNS remained the predominant microorganisms among cases of delayed-onset postoperative endophthalmitis (18.18% of culture-positive cases); our findings reinforce previous reports that CoNS constitute common pathogens in chronic cases of postoperative endophthalmitis. We also identified three cases each of *S. aureus, E. faecalis*, and fungal isolates. Notably, over half of delayed-onset culture-positive cases followed glaucoma surgery, with *Streptococcus* spp. being the most frequent, aligning with previous findings in bleb-associated infections.[30] The prevalence of other bacterial species can vary in delayed-onset endophthalmitis, highlighting the importance of understanding the microbial profile to ensure effective treatment.

All five cases of fungal postoperative endophthalmitis in our study presented with delayed onset. Two required enucleations, while the remaining eyes were salvaged but had poor final visual acuity. This aligns with prior reports that fungal endophthalmitis often results in poor visual outcomes.[40] *Aspergillus* is known for its aggressive course and high risk of vision loss, whereas data on *Penicillium* and *Rigidoporus* remain limited. Current strategies involve PPV, intravitreal amphotericin (5–10 mg/0.1 mL) or voriconazole, and systemic antifungal therapy.[41,42] Given the indolent nature of delayed-onset fungal infections, prolonged systemic treatment (6 weeks to 6 months) may be warranted to improve outcomes.[42]

Importantly, clinical outcomes vary among bacterial species. *P. aeruginosa* infections were associated with the worst visual outcomes, as indicated by the absence of light perception in all three affected patients. Similarly, Lin et al[43] reported dismal visual outcomes in cases of *P. aeruginosa* endophthalmitis, such that nearly all patients experienced final VA of counting fingers or worse; additionally, the rate of evisceration was high. In contrast, *S. aureus* and CoNS exhibited less virulence, resulting in better median final VA. These findings emphasize the importance of identifying specific microbial profiles to predict clinical outcomes and tailor treatment strategies.

Retinal detachment (RD) was identified in a small proportion of eyes with postoperative endophthalmitis (4.9%), though underreporting may have contributed to this low rate. All culture-positive RD cases involved bacterial pathogens and had poor visual outcomes (median final VA: 2.3 logMAR). Zhang et al[44] also reported worse prognosis and higher complication rates in eyes with RD. At our center, silicone oil is routinely used in eyes with concurrent RD for its antimicrobial and tamponade properties, which may help reduce RD recurrence. Other studies have shown that the risk of RD is reduced in eyes with adjuvant silicone oil implantation.[45,46]

In this study, several factors were identified as significantly influencing visual outcomes in postoperative endophthalmitis. These factors included diabetes mellitus (OR=2.7), VA at initial presentation of 20/200 or worse (OR=35.9) and delayed-onset postoperative endophthalmitis (OR=3.9). Diabetic patients may be more susceptible to infection due to impaired neutrophil function and hyperglycemia-related immune dysfunction.[47,48] An additional reported risk factor is renal disease.[16] Despite the significant morbidity associated with infectious endophthalmitis, this study highlights the potential benefits for microbiological analysis and prompt, tailored antimicrobial and/or surgical interventions in improving visual outcomes, even in cases with poor initial VA.

Conclusions

Postoperative endophthalmitis most commonly followed cataract surgery. Coagulase-negative *Staphylococcus* species were the leading causative microorganisms in both acute- and delayed-onset cases. Immediate PPV with intravitreal injection was the most frequent treatment, yielding significant improvements in VA, with a median final VA of 20/200 and a globe salvage rate of 96.3%. Visual improvement was achieved in most cases, though factors such as diabetes mellitus, poor VA at initial presentation and delayed-onset endophthalmitis were significantly associated with worse outcomes. These findings underscore the importance of timely and appropriate management to optimize visual and anatomical outcomes.

Abbreviations

CI, confidence interval; CoNS, coagulase-negative *Staphylococcus*; ESCRS, European Society of Cataract and Refractive Surgeons; EVS, Endophthalmitis Vitrectomy Study; IQR, interquartile range; IVI, intravitreal injection; logMAR: logarithm of the minimum angle of resolution; OR, odd ratio; PPV, pars plana vitrectomy; RD, retinal detachment; RNA, ribonucleic acid; rRNA, ribosomal RNA; VA, visual acuity.

Funding

There is no funding to report.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Kamalarajah S, Silvestri G, Sharma N, et al. Surveillance of endophthalmitis following cataract surgery in the UK. *Eye*. 2004;18(6):580–587. doi:10.1038/sj.eye.6700645
2. Lundström M, Wejde G, Stenevi U, Thorburn W, Montan P. Endophthalmitis after cataract surgery: a nationwide prospective study evaluating incidence in relation to incision type and location. *Ophthalmology*. 2007;114(5):866–870. doi:10.1016/j.ophtha.2006.11.025
3. Patwardhan A, Rao GP, Saha K, Craig EA. Incidence and outcomes evaluation of endophthalmitis management after phacoemulsification and 3-piece silicone intraocular lens implantation over 6 years in a single eye unit. *J Cataract Refract Surg*. 2006;32(6):1018–1021. doi:10.1016/j.jcrs.2006.02.034
4. Sachdeva MM, Moshiri A, Leder HA, Scott AW. Endophthalmitis following intravitreal injection of anti-VEGF agents: long-term outcomes and the identification of unusual micro-organisms. *J Ophthalmic Inflammation Infection*. 2016;6:1–7. doi:10.1186/s12348-015-0069-5
5. Barry P, Seal DV, Gettinby G, et al. ESCRS study of prophylaxis of postoperative endophthalmitis after cataract surgery: preliminary report of principal results from a European multicenter study. *J Cataract Refract Surg*. 2006;32(3):407–410. doi:10.1016/j.jcrs.2006.02.021
6. Scott IU, Harry W, Flynn J, et al. Endophthalmitis after 25-gauge and 20-gauge pars plana vitrectomy: incidence and outcomes. *Retina*. 2008;28(1):138–142. doi:10.1097/IAE.0b013e31815e9313
7. Johnson MW, Doft BH, Kelsey SF, et al. The endophthalmitis vitrectomy study: relationship between clinical presentation and microbiologic spectrum. *Ophthalmology*. 1997;104(2):261–272. doi:10.1016/S0161-6420(97)30326-1

8. Varliero G, Lebre PH, Stevens MI, Czechowski P, Makhalanyane T, Cowan DA. The use of different 16S rRNA gene variable regions in biogeographical studies. *Environ Microbio Rep*. 2023;15(3):216–228. doi:10.1111/1758-2229.13145
9. Pryce T, Palladino S, Kay I, Coombs G. Rapid identification of fungi by sequencing the ITS1 and ITS2 regions using an automated capillary electrophoresis system. *Med Mycol*. 2003;41(5):369–381. doi:10.1080/13693780310001600435
10. Vitrectomy E. Results of the endophthalmitis vitrectomy study. *Arch Ophthalmol*. 1995;113:1479–1496.
11. Choi JA, Chung SK. Postoperative endophthalmitis following cataract surgery in Asia. *Int Scholarly Res Notices*. 2011;2011(1):917265.
12. Wong TY, Chee S-P. The epidemiology of acute endophthalmitis after cataract surgery in an Asian population. *Ophthalmology*. 2004;111(4):699–705. doi:10.1016/j.ophtha.2003.07.014
13. Lalitha P, Rajagopalan J, Prakash K, Ramasamy K, Prajna NV, Srinivasan M. Postcataract endophthalmitis in South India: incidence and outcome. *Ophthalmology*. 2005;112(11):1884–1889. doi:10.1016/j.ophtha.2005.05.020
14. Doft B, Nakamura T, Walonker A, Doft BH, Karenchak LM. Results of the endophthalmitis vitrectomy study: a randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. *Am J Ophthalmol*. 1995;119:62–64. doi:10.1016/s0002-9394(14)73814-0
15. Dib B, Morris RE, Oltmanns MH, Sapp MR, Glover JP, Kuhn F. Complete and early vitrectomy for endophthalmitis after cataract surgery: an alternative treatment paradigm. *Clin Ophthalmol*. 2020;Volume 14:1945–1954. doi:10.2147/OPTH.S253228
16. Peng K-L, Kung Y-H, Tsai H-S, Wu -T-T. Treatment outcomes of acute postoperative infectious endophthalmitis. *BMC Ophthalmology*. 2021;21:1–9. doi:10.1186/s12886-021-02144-6
17. Rahmani S, Eliott D. Postoperative endophthalmitis: a review of risk factors, prophylaxis, incidence, microbiology, treatment, and outcomes. *Seminars Ophthalmol*. 2017;33:1–7. doi:10.1080/08820538.2017.1353826
18. Barry P, Cordovés L, Gardner S. ESCRS guidelines for prevention and treatment of endophthalmitis following cataract surgery: data, dilemmas and conclusions. *Eur Soci Cataract Refractive Surg*. 2013;1–44.
19. Hatch WV, Cernat G, Wong D, Devenyi R, Bell CM. Risk factors for acute endophthalmitis after cataract surgery: a population-based study. *Ophthalmology*. 2009;116(3):425–430. doi:10.1016/j.ophtha.2008.09.039
20. Ng JQ, Morlet N, Bulsara MK, Semmens JB. Reducing the risk for endophthalmitis after cataract surgery: population-based nested case-control study: endophthalmitis population study of Western Australia sixth report. *J Cataract Refract Surg*. 2007;33(2):269–280. doi:10.1016/j.jcrs.2006.10.067
21. Wallin T, Parker J, Jin Y, Kefalopoulos G, Olson RJ. Cohort study of 27 cases of endophthalmitis at a single institution. *J Cataract Refract Surg*. 2005;31(4):735–741. doi:10.1016/j.jcrs.2004.10.057
22. Wong T, Chee S. Risk factors of acute endophthalmitis after cataract extraction: a case-control study in Asian eyes. *Br J Ophthalmol*. 2004;88(1):29–31. doi:10.1136/bjo.88.1.29
23. Mayer E, Cadman D, Ewings P, et al. A 10 year retrospective survey of cataract surgery and endophthalmitis in a single eye unit: injectable lenses lower the incidence of endophthalmitis. *Br J Ophthalmol*. 2003;87(7):867–869. doi:10.1136/bjo.87.7.867
24. Norregaard JC, Thoning H, Bernth-Petersen P, Andersen TF, Javitt JC, Anderson GF. Risk of endophthalmitis after cataract extraction: results from the international cataract surgery outcomes study. *Br J Ophthalmol*. 1997;81(2):102–106. doi:10.1136/bjo.81.2.102
25. Javitt JC, Vitale S, Canner JK, et al. National outcomes of cataract extraction: endophthalmitis following inpatient surgery. *Arch Ophthalmol*. 1991;109(8):1085–1089. doi:10.1001/archopht.1991.01080080045025
26. Kamalarajah S, Ling R, Silvestri G, et al. Presumed infectious endophthalmitis following cataract surgery in the UK: a case–control study of risk factors. *Eye*. 2007;21(5):580–586. doi:10.1038/sj.eye.6702368
27. Clark WL, Kaiser PK, Flynn HW Jr, Belfort A, Miller D, Meisler DM. Treatment strategies and visual acuity outcomes in chronic postoperative Propionibacterium acnes endophthalmitis. *Ophthalmology*. 1999;106(9):1665–1670. doi:10.1016/S0161-6420(99)90348-2
28. Poon E, Poon A, McKelvie P, Levitz L, Zamir E. Delayed bacterial endotheliitis and endophthalmitis 11 years after cataract surgery. *Case Rep Ophthalmol*. 2023;14(1):376–381. doi:10.1159/000531501
29. Lazzarini TA, Al-Khersan H, Patel NA, et al. Chronic, recurrent bacterial endophthalmitis caused by Achromobacter xylosoxidans: clinical features and management. *Int Med Case Rep Jo*. 2020;Volume 13:265–269. doi:10.2147/IMCRJ.S259899
30. Kangas TA, Greenfield DS, Flynn JHW, Parrish IIRK, Palmberg P. Delayed-onset endophthalmitis associated with conjunctival filtering blebs. *Ophthalmology*. 1997;104(5):746–752. doi:10.1016/S0161-6420(97)30238-3
31. Phillips WB, Wong TP, Bergren RL, Friedberg MA, Benson WE. Late onset endophthalmitis associated with filtering blebs. *Slack Incorporated Thorofare*. 1994;88–91.
32. Song A, Scott IU, Flynn MHW, Budenz DL. Delayed-onset bleb-associated endophthalmitis: clinical features and visual acuity outcomes. *Ophthalmology*. 2002;109(5):985–991. doi:10.1016/S0161-6420(02)00965-X
33. Tran KD, Yannuzzi NA, Si N, et al. Clinical features, antimicrobial susceptibilities, and treatment outcomes of patients with culture positive endophthalmitis after penetrating keratoplasty. *Am J Ophthalmol Case Rep*. 2018;9:62–67. doi:10.1016/j.ajoc.2018.01.011
34. Gentile RC, Shukla S, Shah M, et al. Microbiological spectrum and antibiotic sensitivity in endophthalmitis: a 25-year review. *Ophthalmology*. 2014;121(8):1634–1642. doi:10.1016/j.ophtha.2014.02.001
35. Benz MS, Scott IU, Flynn HW Jr, Unonius N, Miller D. Endophthalmitis isolates and antibiotic sensitivities: a 6-year review of culture-proven cases. *Am J Ophthalmol*. 2004;137(1):38–42. doi:10.1016/S0002-9394(03)00896-1
36. Recchia FM, Busbee BG, Pearlman RB, Carvalho-Recchia CA, Ho AC. Changing trends in the microbiologic aspects of postcataract endophthalmitis. *Archives of Ophthalmol*. 2005;123(3):341–346. doi:10.1001/archopht.123.3.341
37. Maalouf F, Abdulaal M, Hamam RN. Chronic postoperative endophthalmitis: a review of clinical characteristics, microbiology, treatment strategies, and outcomes. *Int J Inf*. 2012;2012:1–6. doi:10.1155/2012/313248
38. Shirodkar AR, Pathengay A, Flynn HW Jr, et al. Delayed-versus acute-onset endophthalmitis after cataract surgery. *Am J Ophthalmol*. 2012;153(3):391–398.e2. doi:10.1016/j.ajo.2011.08.029
39. Fox GM, Joondeph BC, Flynn HW, Pflugfelder SC, Roussel TJ. Delayed-onset pseudophakic endophthalmitis: reply. *Am J Ophthalmol*. 1991;111(5):656–657. doi:10.1016/S0002-9394(14)73723-7
40. Narang S, Gupta A, Gupta V, et al. Fungal endophthalmitis following cataract surgery: clinical presentation, microbiological spectrum, and outcome. *Am J Ophthalmol*. 2001;132(5):609–617. doi:10.1016/S0002-9394(01)01180-1

41. Weishaar PD, Flynn HW Jr, Murray TG, et al. Endogenous Aspergillus endophthalmitis: clinical features and treatment outcomes. *Ophthalmology*. 1998;105(1):57–65. doi:10.1016/S0161-6420(98)71225-3
42. Chakrabarti A, Shivaprakash MR, Singh R, et al. Fungal endophthalmitis: fourteen years' experience from a center in India. *Retina*. 2008;28 (10):1400–1407. doi:10.1097/IAE.0b013e318185e943
43. Lin J, Huang S, Liu M, Lin L, Gu J, Duan F. Endophthalmitis caused by pseudomonas aeruginosa: clinical characteristics, outcomes, and antibiotics sensitivities. *Journal of Ophthalmol*. 2022;2022:1–6. doi:10.1155/2022/1265556
44. Zhang WF ZX, Meng LH, Chen H, Chen YX, Chen Y-X. Endophthalmitis at a tertiary referral center: characteristics and treatment outcomes over three decades. *Front Cell Dev Biol*. 2022;10:952375. doi:10.3389/fcell.2022.952375
45. Nagpal M, Jain P, Nagpal K. Pars plana vitrectomy with or without silicone oil endotamponade in surgical management of endophthalmitis. *Asia-Pac J Ophthalmol*. 2012;1:216–221. doi:10.1097/APO.0b013e31826000cd
46. Do T, Hon D, Aung T, Hien N, Cowan C. Bacterial endogenous endophthalmitis in Vietnam: a randomized controlled trial comparing vitrectomy with silicone oil versus vitrectomy alone. *Clin Ophthalmol*. 2014;8:1633–1640. doi:10.2147/OPTH.S67589
47. Pozzilli P, Leslie RD. Infections and diabetes: mechanisms and prospects for prevention. *Diabet Med*. 1994;11(10):935–941. doi:10.1111/j.1464-5491.1994.tb00250.x
48. Geerlings S, Hoepelman A. Immune dysfunction in patients with diabetes mellitus (DM). *FEMS Immunol med microbio*. 2000;26:259–265. doi:10.1111/j.1574-695X.1999.tb01397.x