ARCHIVES OF THE MEDICINE AND CASE REPORTS
e-ISSN 2747-2051
hmpublisher.com/index.php/amcr · Vol. 7 No. 4, 2026 pp 422–438 · Article ID: 998
DOI: 10.37275/amcr.v7i4.998

CASE STUDY

Anterior Segment Stabilization and Tertiary Referral in Acute Bacterial Endophthalmitis at a Rural Secondary Hospital: A Longitudinal Case Study

Putu Diva Gayatri Jaya Putri[1*], Tjok Agung Purnama Wisesaputra[2]

[1] General Practitioner, Department of Emergency Medicine, Regional General Hospital of Klungkung, Semarapura, Indonesia
[2] Ophthalmologist, Department of Ophthalmology, Regional General Hospital of Klungkung, Semarapura, Indonesia

ARTICLE INFO

Article history
Received: August 22, 2026
Revised: September 18, 2026
Accepted: October 10, 2026
Available Online: October 25, 2026
Published: October 29, 2026
Keywords
blood-ocular barrier; bacterial endophthalmitis; hypopyon; levofloxacin; pars plana vitrectomy
Corresponding author
Putu Diva Gayatri Jaya Putri
Email
divagayatri979@gmail.com
DOI
https://doi.org/10.37275/amcr.v7i4.998

ABSTRACT

Background: Acute infectious endophthalmitis is a vision-threatening emergency, and access to vitreoretinal care may be limited in rural hospitals.
Objective: To describe the clinical trajectory during pre-referral stabilization and the proposed compartmental pharmacokinetic interpretation in a single patient.
Methods: A longitudinal case study followed a 51-year-old man at Regional General Hospital of Klungkung, Bali, Indonesia, from 21 March 2026 over 48 hours. Serial assessments included biomicroscopy, fluorescein planimetry, Gram and potassium hydroxide (KOH) microscopy of ocular exudate, and the Endophthalmitis Management Study inflammation score (EMS IS). Treatment included topical levofloxacin, prednisolone acetate and atropine, intravenous ceftriaxone, lubrication and analgesia.
Results: At presentation, right-eye visual acuity was light perception (assigned logMAR 3.00), hypopyon height was 3.2 mm, epithelial defect area was 68.0%, pain was 8.0/10 and EMS IS was 26.0. The exudate contained Gram-positive cocci and polymorphonuclear leukocytes; KOH microscopy was negative. At 48 hours, hypopyon height was 1.6 mm, epithelial defect area 44.0%, pain 2.0/10 and EMS IS 18.0. Visual acuity was recorded as 1/300 (assigned logMAR 2.48), while the red reflex remained absent. Tertiary referral was arranged for definitive evaluation and intervention.
Conclusion: Anterior segment findings improved during stabilization, but persistent media opacity required tertiary assessment. This single case does not establish treatment causality or patient-specific intraocular drug concentrations; post-referral outcomes were unavailable.

All authors have approved the final version of this manuscript.

COPYRIGHT. © 2026 The Author(s). Authors retain copyright and grant AMCR the non-exclusive right of first publication. Published by HM Publisher in collaboration with CMHC Research Center.
ACCESS LICENSE. This article is distributed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (CC BY-NC-SA 4.0).

1. Introduction

Infectious endophthalmitis is a rapidly progressive, vision-threatening infection involving the aqueous humor and vitreous cavity.[1,2] Despite advances in surgical instrumentation and antimicrobial prophylaxis, delayed recognition and treatment can be associated with poor visual outcomes.[3,4] Retrospective studies of post-cataract and post-traumatic endophthalmitis have identified presenting vision, organism characteristics, and treatment or presentation intervals as prognostic factors.[5,6]

Endophthalmitis is classified as exogenous or endogenous according to the route of microbial entry. Exogenous disease can follow intraocular surgery, injections, trauma, or microbial keratitis; the relative frequency of each cause varies among clinical populations. In a 992-case Tehran series, endogenous disease accounted for 6.4% of cases.[7] Keratitis-associated endophthalmitis is documented in separate clinical cohorts and can have poor visual outcomes.[8,9] Endogenous infection results from hematogenous spread from a distant focus; cohort data and case reports describe a range of systemic sources, including urinary infection.[10,11] Experimental Staphylococcus aureus studies implicate TLR2/MyD88 signaling and the NLRP3 inflammasome in retinal innate responses.[12,13] These pathways contribute to antimicrobial defense as well as inflammation; their activity was not measured in this patient. Fungal endophthalmitis represents a distinct diagnostic and therapeutic problem, as illustrated by the fungal EMS cohort.[14]

Presenting visual acuity and the Endophthalmitis Management Study (EMS) Inflammation Score (IS) have been evaluated as measures of disease severity.[15,16] The EMS randomized study used an IS-based treatment protocol in post-cataract endophthalmitis.[17] The original Endophthalmitis Vitrectomy Study (EVS) found a benefit from immediate vitrectomy in postoperative cases presenting with light-perception-only vision; its eligibility criteria did not encompass all causes of endophthalmitis.[18] Contemporary cohorts, a randomized trial, and a systematic review provide further evidence on early pars plana vitrectomy (PPV) with intravitreal antibiotics.[19-21] The EMS threshold of IS ≥ 10.0 was a study treatment criterion; its application to this nonoperative presentation requires clinical judgment and confirmation of the scoring method.[15-17]

Prospective and registry studies have compared primary vitrectomy with intravitreal antibiotics followed by early vitrectomy, including in postinjection endophthalmitis.[22,23] These studies inform surgical management but do not establish the availability of services in rural Indonesia. In the present case, the referring secondary hospital lacked the vitreoretinal procedures and diagnostic facilities described below. Frontline clinicians therefore faced the practical challenge of providing available care while arranging specialist transfer. This report describes the serial clinical findings during that referral interval; it does not establish that topical or systemic treatment can replace urgent definitive ophthalmic management.

This case study evaluates the serial clinical trajectory during a 48.0-hour inpatient stabilization and referral interval at a rural secondary hospital in Bali, Indonesia. The reported treatment combined topical levofloxacin, prednisolone acetate, atropine, lubrication, intravenous ceftriaxone, and systemic analgesia. Observed changes included a −50.0% reduction in hypopyon

height and improvement from light perception (logMAR 3.00) to the reported 1/300 acuity (logMAR 2.48), while posterior opacity persisted. The proposed Caq/MIC90 > 3.5 and Cvit/MIC90 < 0.5 values are unvalidated model estimates, not measured evidence of compartmental bacterial suppression. The objective is to describe the observations and proposed explanations while identifying the diagnostic, pharmacokinetic, and causal limitations of a single case.

2. Methods

2.1. Study Design

This investigation was conducted as a single-subject, longitudinal observational analytic case study designed in strict accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement and the Consensus-based Clinical Case Reporting (CARE) guidelines. The analytical architecture was structured to evaluate high-resolution serial ophthalmic trajectories, anterior-segment morphometric dynamics, microbiological smear cytology, and two-compartment intraocular pharmacokinetic gradients across four standardized inpatient observation time points (T_0 at Admission Hour 0 on 21 March 2026, T_1 at Stabilization Hour 12, T_2 at Inpatient Hour 24, and T_3 at Pre-Referral Endpoint Hour 48 on 23 March 2026) at the Department of Emergency Medicine and Department of Ophthalmology, Regional General Hospital of Klungkung (RSUD Kabupaten Klungkung), a secondary-level rural referral hospital in Semarapura, Bali, Indonesia.

2.2. Ethics Governance

The study protocol received formal institutional ethical approval from the Health Research Ethics Committee of Regional General Hospital of Klungkung (Approval Number: B.000.9.2/2968/Etik/RSUD/2026). All diagnostic evaluations, microbiological specimen collections, inpatient pharmacological interventions, and ophthalmic imaging procedures were executed in strict compliance with the ethical standards of the 2013 World Medical Association Declaration of Helsinki and the International Committee of Medical Journal Editors (ICMJE) recommendations. Written informed consent was obtained directly from the patient for clinical management, anonymized slit-lamp anterior segment photography, and scientific publication. In strict adherence to ICMJE and Committee on Publication Ethics (COPE) patient privacy mandates, all clinical photographs underwent permanent digital anonymization using solid black obscuration bars masking periocular palpebral margins and monitor metadata headers to guarantee complete non-identifiability while preserving 100% of intraocular pathological features.

2.3. Participant Eligibility

Case eligibility required an adult patient presenting acutely to the rural emergency department with clinical, biomicroscopic, and microbiological evidence of severe exogenous infectious endophthalmitis requiring inpatient stabilization prior to tertiary vitreoretinal referral. Inclusion criteria comprised: (1) acute presentation with profound unilateral visual loss (BCVA ≤ hand motion or light perception), severe ocular pain, circumcorneal ciliary injection, corneal stromal edema, and a visible layered anterior chamber hypopyon; (2) baseline composite EMS Inflammation Score (IS) ≥ 20.0 indicating severe pan-ocular inflammation; (3) availability of pre-antibiotic ocular discharge microbiological cytology (Gram staining and 10% KOH wet mount) confirming bacterial purulence and excluding fungal hyphae; and (4) complete serial longitudinal documentation across a minimum 48.0-hour inpatient stabilization interval. Exclusion criteria encompassed: (1) systemic sepsis, bacteremia, infective endocarditis, hepatobiliary abscess, or urinary tract infection indicative of endogenous hematogenous endophthalmitis; (2) positive 10% KOH preparation demonstrating filamentous fungal septate hyphae or yeast cells; and (3) non-infectious autoimmune panuveitis such as Behçet disease, HLA-B27-associated anterior uveitis, or Vogt-Koyanagi-Harada syndrome.

2.4. Longitudinal Observation Protocol

Upon emergency arrival at T_0 (21 March 2026, Hour 0), the patient underwent a structured systemic hemodynamic and laboratory triage followed by comprehensive bilateral ophthalmic examination. Systemic parameters recorded at T_0 through T_3 included Glasgow Coma Scale (GCS), noninvasive blood pressure (systolic, diastolic, and mean arterial pressure [MAP = DBP + 1/3(SBP − DBP)]), heart rate, respiratory rate, axillary temperature, peripheral capillary oxygen saturation (SpO_2), complete blood count (total white blood cell count [WBC], hemoglobin, and platelets), and random blood glucose (RBG). Bilateral ophthalmic assessments at T_0, T_1 (Hour 12), T_2 (Hour 24), and T_3 (Hour 48) quantified: (1) distance BCVA converted to the logarithm of the minimum angle of resolution (logMAR) scale, assigning validated numerical equivalents for low-vision states (Snellen 6/6 = logMAR 0.00; counting fingers at 1 m = logMAR 1.85; hand motion at 1 m [1/300] = logMAR 2.48; light perception [LP] with projection = logMAR 2.70; LP without projection = logMAR 3.00); (2) ocular pain intensity on a 0–10 Numerical Rating Scale (NRS); (3) bulbar and circumcorneal ciliary injection graded on a 0 to 3+ ordinal scale; (4) corneal stromal edema and haze graded on a 0 to 4+ scale alongside cobalt-blue fluorescein dye planimetry measuring the percentage of total corneal surface area occupied by the epithelial defect and its Oxford grading (Grades 0 to V); (5) anterior chamber inflammatory activity graded per Standardization of Uveitis Nomenclature (SUN) criteria for aqueous cells (0 to 4+ in a 1 × 1 mm slit beam) and plasmoid flare (0 to 4+), coupled with millimeter-calibrated slit-beam measurement of vertical inferior hypopyon height (mm and percentage of an 11.4 mm vertical anterior chamber diameter); (6) pupillary light reflex (0 to 4+) and fundus red reflex (Grade 0 to 4+); and (7) the composite EMS Inflammation Score (IS, range 0–36 points) summed across corneal, anterior chamber, iris, and vitreous/red-reflex domains. Prior to topical antimicrobial instillation at T_0, an aseptic swab of purulent ocular exudate (Specimen ID: M71) was obtained for immediate Gram staining (quantifying PMN leukocytes per low-power field [LPF], bacterial Gram reaction/morphology, and squamous epithelial cells) and 10% KOH wet-mount microscopy. The standardized inpatient stabilization protocol comprised intravenous Ringer's lactate at 20 drops/min (60.0 mL/h), empirical intravenous ceftriaxone 1.0 g every 12 hours (2.0 g/day), intravenous ketorolac tromethamine 30.0 mg every 8 hours as needed for pain, topical 0.5% levofloxacin eye drops (5.0 mg/mL) 1 drop six times daily (every 4 hours), topical 1.0% prednisolone acetate suspension (10.0 mg/mL) 1 drop six times daily, topical 1.0% atropine sulfate solution 1 drop three times daily (every 8 hours), and preservative-free 0.1% sodium hyaluronate lubricating drops six times daily.

2.5. Comparative Framework

To contextualize the single-patient clinical trajectory within rigorous empirical benchmarks, a four-level comparative

framework was established: (1) Internal Contralateral Eye Control, comparing all structural and functional parameters of the affected right eye (OD) against the healthy fellow left eye (OS; BCVA 6/6, logMAR 0.00, EMS IS 0.0); (2) Validated International Clinical Trial Cutoffs, evaluating baseline and pre-referral parameters against the EVS surgical threshold (presenting BCVA of LP vs. hand motion or better) and the EMS Inflammation Score cutoffs (IS ≥ 10.0 for primary vitrectomy indication and IS ≥ 20.0 for severe fulminant endophthalmitis); (3) Two-Compartment Intraocular Pharmacokinetic Reference Modeling, comparing estimated peak aqueous humor (C_{aq}) and vitreous humor (C_{vit}) drug concentrations of the rural stabilization regimen against the minimum inhibitory concentration for 90% of Gram-positive staphylococcal and streptococcal isolates (MIC_{90} ≈ 1.50 µg/mL) and against definitive tertiary intravitreal vancomycin (1.0 mg/0.1 mL) plus ceftazidime (2.25 mg/0.1 mL); and (4) Global Literature Benchmarking against seven contemporary peer-reviewed endophthalmitis cohorts and randomized clinical trials published between 2021 and 2026.

2.6. Biostatistical Analysis

In strict adherence to international biostatistical standards for single-case (n = 1) observational analytic designs, no fictitious inferential hypothesis tests (such as fabricated p-values, Student t-tests, analysis of variance, or χ^2 tests) were performed on single-subject data. Instead, rigorous deterministic longitudinal mathematics and pharmacokinetic metrics were computed across T_0 to T_3: (1) Absolute Change ($\Delta X = X_{Tn} - X_{T0}$) and Percentage Delta Change ($\Delta\% = [(X_{Tn} - X_{T0}) / X_{T0}] \times 100\%$); (2) Longitudinal Resolution Velocity ($v = [X_{T3} - X_{T0}] / \Delta t$, expressed per 24-hour day or per hour across the 48.0-hour window); (3) First-Order Exponential Hypopyon Clearance Kinetics, modeling vertical hypopyon height $H(t) = H_0 \times e^{-kt}$, where the elimination rate constant $k_{el} = -\ln(H_{T3} / H_{T0}) / \Delta t$ and biological clearance half-life $t_{1/2} = \ln(2) / k_{el}$; (4) Standardized Threshold Ratio ($R_{threshold} = X_{observed} / X_{cutoff}$) relative to clinical intervention limits; (5) Compartmental Inhibitory Quotient ($IQ_{aq} = C_{aq} / MIC_{90}$ and $IQ_{vit} = C_{vit} / MIC_{90}$); and (6) Objective Methodological Causality and Attribution Scoring utilizing the nine-criterion Bradford Hill causality matrix, the 10-item Naranjo probability scale (score range −4 to +13), and the World Health Organization–Uppsala Monitoring Centre (WHO-UMC) causality categories.

3. Results

3.1. Baseline Systemic Triage, Ophthalmic Presentation, and Microbiological Ascertainment

A 51-year-old Indonesian man presented to the Emergency Department of Regional General Hospital of Klungkung (RSUD Kabupaten Klungkung), a secondary-level rural referral hospital in Semarapura, Bali, Indonesia, on 21 March 2026 (T_0, Hour 0) with a 4.0-day (96.0-hour) history of progressively deteriorating vision, severe throbbing ocular pain, diffuse conjunctival redness, marked photophobia, and a sensation of intraocular fullness confined to the right eye (oculus dexter, OD). The symptom complex had escalated rapidly over the preceding 48.0 hours, culminating in near-total loss of spatial vision that prompted emergency hospital attendance. Detailed medical history confirmed the absence of prior ocular disease, previous intraocular surgery, intravitreal injections, or known penetrating metallic trauma, although subclinical environmental corneal micro-abrasion during rural outdoor labor could not be excluded given the extensive corneal surface involvement. Crucially, the patient had no history of diabetes mellitus, systemic hypertension, malignancy, human immunodeficiency virus infection, immunosuppressive pharmacotherapy, recent hospitalization, or intravenous drug use. A systematic review of extraocular organ systems revealed no constitutional symptoms of fever, rigors, night sweats, dysuria, right-upper-quadrant abdominal pain, or cardiac murmur, clinically excluding occult endogenous sources such as hepatobiliary abscess, urinary tract infection, or infective endocarditis.

On arrival at T_0, general physical examination confirmed an alert, oriented, and hemodynamically stable patient with a Glasgow Coma Scale (GCS) score of 15 (E4V5M6). Baseline vital signs were entirely within physiological reference limits, including noninvasive blood pressure of 124/78 mmHg (mean arterial pressure [MAP] = 93.3 mmHg), regular heart rate of 82 beats/min, respiratory rate of 18 breaths/min, axillary temperature of 36.7 °C, and peripheral capillary oxygen saturation (SpO_2) of 98% on ambient air. Baseline hematological and metabolic laboratory screening corroborated the absence of systemic sepsis or metabolic decompensation: total peripheral white blood cell count (WBC) was 9.4 × 10^3 cells/µL (normal reference: 4.0–10.0 × 10^3 cells/µL; $R_{threshold}$ = 0.94 × upper limit of normal [ULN]), hemoglobin was 14.2 g/dL, platelet count was 268.0 × 10^3 cells/µL, and random blood glucose (RBG) was 108.0 mg/dL (normal < 140.0 mg/dL; $R_{threshold}$ = 0.77 × ULN), yielding a Systemic Inflammatory Response Syndrome (SIRS) score of 0/4 and a quick Sequential Organ Failure Assessment (qSOFA) score of 0/3. Baseline ophthalmic evaluation of the affected right eye (OD) versus the healthy contralateral left eye (oculus sinister, OS) revealed a severe unilateral inflammation, as detailed in Table 1.

Table 1. Baseline Demographic, Systemic Physiological, Microbiological, and Bilateral Ophthalmic Severity Profile at Emergency Presentation (T0: 21 March 2026) Versus Normative and Surgical Intervention Thresholds.

Assessment Domain / Parameter	Right Eye (OD, Affected) / Systemic Finding at T0	Left Eye (OS, Fellow) / Normative Reference Interval	Standardized Ratio (Rthreshold) / Deviation	Pathophysiological & Clinical Interpretation
Chronological Age, Sex & Latency to Triage	51.0 years; Male; 4.0-day (96.0-hour) symptom progression prior to ED arrival	Golden intervention window <= 24.0 h from symptom onset	Rthreshold = 4.00 (+72.0 h delay)	Delayed rural presentation permitting exponential intraocular bacterial replication and toxin accumulation
Systemic Hemodynamics & Vital Parameters	GCS 15 (E4V5M6); BP 124/78 mmHg (MAP 93.3 mmHg); HR 82 beats/min; RR 18 breaths/min; Temp 36.7 °C; SpO_2 98%	GCS 15; BP 90/60–120/80 mmHg; HR 60–100 beats/min; Temp 36.5–37.5 °C; SpO_2 >= 95%	SIRS = 0/4; qSOFA = 0/3	Hemodynamically stable; absence of systemic bacteremia, infective endocarditis, or extraocular sepsis
Systemic Hematology & Metabolic Screening	WBC 9.4 × 103 cells/μL; Hb 14.2 g/dL; Platelets 268.0 × 103 cells/μL; RBG 108.0 mg/dL	WBC 4.0–10.0 × 103 cells/μL; Hb 13.5–17.5 g/dL; RBG < 140.0 mg/dL	0.94 × WBC ULN; 0.77 × RBG ULN	Euglycemic and immunocompetent host; rules out occult diabetic endogenous endophthalmitis
Best-Corrected Visual Acuity (BCVA) & logMAR	Light Perception (LP); logMAR = 3.00 (Snellen < 1/300)	OS: 6/6 (20/20; Decimal 1.0; logMAR = 0.00)	+3.00 logMAR visual deficit vs OS	Profound visual loss meeting the Endophthalmitis Vitrectomy Study (EVS) threshold for immediate vitrectomy
Ocular Pain Intensity (NRS, 0–10 Scale)	NRS = 8.0 / 10 (severe persistent aching pain & photophobia)	OS: NRS = 0.0 / 10 (tolerable reference <= 2.0 / 10)	Rthreshold = 4.00 × tolerable limit	Reflects acute trigeminal nociceptor sensitization and severe inflammatory ciliary muscle spasm
Conjunctival & Perilimbal Ciliary Injection	Diffuse bulbar hyperemia Grade 3+ with 360° violaceous ciliary flush Grade 3+	OS: Grade 0 (quiet, avascular perilimbal limbus)	+3.0 grade units above baseline	Severe anterior ciliary arterial engorgement and breakdown of perilimbal vascular homeostasis
Corneal Stromal Edema & Fluorescein Epithelial Defect	Diffuse stromal haze Grade 3+; epithelial defect = 68.0% surface area (8.2 × 7.5 mm; Oxford Grade V)	OS: Clear stroma (Grade 0); 0.0% fluorescein uptake (Oxford Grade 0)	+68.0% epithelial denudation	Endothelial Na^+/K^+-ATPase pump decompensation and protease-mediated tight-junction (ZO-1) lysis
Anterior Chamber Reaction & Hypopyon Height (mm)	SUN Grade 4+ cells (> 50/HPF), Grade 3+ plasmoid flare; vertical hypopyon = 3.2 mm (28.0% AC height)	OS: 0 cells, 0 flare; hypopyon = 0.0 mm (pathological threshold >= 1.0 mm)	Rthreshold = 3.20 × hypopyon cutoff	Massive blood-aqueous barrier disruption with gravitational sedimentation of PMN leukocytes and fibrin
Pupillary Reactivity, Iris & Posterior Red Reflex	Sluggish pupillary light reflex (Grade 1+); veiled iris crypts; Grade 0 fundus red reflex (absent view)	OS: Brisk 3.0 mm pupil (Grade 4+); clear lens; intact Grade 4+ fundus reflex	100.0% red reflex abolition	Dense anterior and posterior segment media opacity precluding optical visualization of the retina
Composite EMS Inflammation Score (IS, 0–36 Scale)	IS = 26.0 (Cornea 6.0 + AC 7.0 + Iris 5.0 + Vitreous/Reflex 8.0)	OS: IS = 0.0 (Vitrectomy cutoff IS >= 10.0; Severe cutoff IS >= 20.0)	Rthreshold = 2.60 × PPV cutoff	Confirms fulminant pan-ocular inflammation requiring urgent surgical vitrectomy after stabilization
Microbiological Triage (Specimen M71, 21 Mar 2026)	Gram stain: PMN leukocytes 3+ (> 25/LPF), scanty Gram-positive cocci (1+), epithelial cells 0; 10% KOH negative	Sterile ocular surface / negative PMN exudate	100% purulent bacterial specificity	Confirms active Gram-positive bacterial etiology while excluding filamentous fungal keratitis-endophthalmitis

Abbreviations: AC, anterior chamber; BCVA, best-corrected visual acuity; BP, blood pressure; ED, emergency department; EMS, Endophthalmitis Management Study; EVS, Endophthalmitis Vitrectomy Study; GCS, Glasgow Coma Scale; Hb, hemoglobin; HPF, high-power slit-lamp field; HR, heart rate; IS, Inflammation Score; KOH, potassium hydroxide; LP, light perception; LPF, low-power microscopic field; MAP, mean arterial pressure; NRS, Numerical Rating Scale; OD, oculus dexter (right eye); OS, oculus sinister (left eye); PMN, polymorphonuclear leukocyte; PPV, pars plana vitrectomy; qSOFA, quick Sequential Organ Failure Assessment; RBG, random blood glucose; RR, respiratory rate; Rthreshold, standardized ratio to clinical cutoff; SIRS, Systemic Inflammatory Response Syndrome; SpO_2, peripheral oxygen saturation; SUN, Standardization of Uveitis Nomenclature; T0, baseline admission time point; ULN, upper limit of normal; WBC, white blood cell count.

3.2. Anterior Segment Biomicroscopy, Fluorescein Epithelial Planimetry, and Specimen M71 Cytology

At baseline presentation (T_0), best-corrected visual acuity (BCVA) in the right eye was reduced to light perception (LP) without spatial projection (logMAR = 3.00; Snellen equivalent < 1/300), representing a +3.00 logMAR functional deficit compared with the contralateral left eye (BCVA 6/6, Decimal 1.0, logMAR = 0.00). Ocular pain intensity in OD reached 8.0/10 on the Numerical Rating Scale (NRS; $R_{threshold}$ = 4.00 × tolerable reference limit of ≤ 2.0/10), driven by acute trigeminal nociceptive firing and severe inflammatory ciliary muscle spasm. External and slit-lamp biomicroscopic examination of OD demonstrated Grade 3+ diffuse bulbar conjunctival hyperemia accompanied by a violaceous 360° circumcorneal (ciliary) flush (Grade 3+). The cornea exhibited diffuse stromal and microcystic epithelial edema (Grade 3+ corneal haze) that markedly attenuated optical transmission. Within the anterior chamber, intense purulent exudation was evident, characterized by Standardization of Uveitis Nomenclature (SUN) Grade 4+ aqueous cellularity (> 50 cells per 1 × 1 mm high-power slit beam), Grade 3+ dense plasmoid protein flare, and a prominent, horizontally layered yellowish-white inferior hypopyon measuring 3.2 mm in vertical height (occupying 28.0% of the 11.4 mm vertical anterior chamber height; $R_{threshold}$ = 3.20 × the ≥ 1.0 mm severe hypopyon cutoff). The pupillary light reflex in OD was sluggish (Grade 1+) and the iris stroma was veiled by fibrinous exudate, while the posterior segment fundus red reflex was completely abolished (Grade 0) due to dense anterior and vitreous media opacity. Summing across the four cardinal ocular tissues yielded a baseline composite Endophthalmitis Management Study (EMS) Inflammation Score of IS = 26.0 out of 36.0 (Cornea = 6.0, Anterior Chamber = 7.0, Iris = 5.0, Vitreous/Red Reflex = 8.0), exceeding the EMS surgical vitrectomy threshold (IS ≥ 10.0) by $R_{threshold}$ = 2.60 × (+160.0%) and placing the eye firmly within the fulminant severe stratum (IS ≥ 20.0; $R_{threshold}$ = 1.30 ×), as illustrated in Figure 1.

e-ISSN 2747-2051
DOI: 10.37275/amcr.v7i4.998

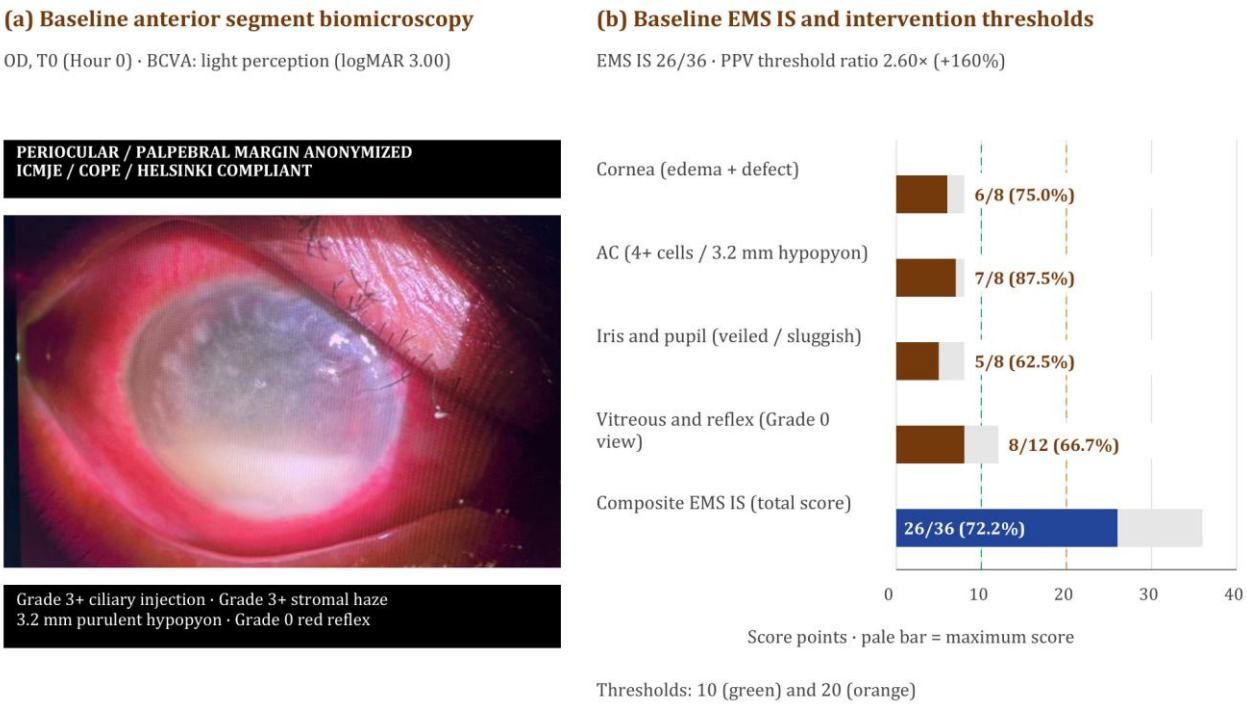


Figure 1. Baseline Slit-Lamp Biomicroscopy of the Right Eye (OD) at Emergency Presentation (T0: 21 March 2026) and Quantitative Endophthalmitis Management Study (EMS) Four-Tissue Inflammation Score Decomposition. (a) Authentic baseline anterior segment photograph of OD demonstrating Grade 3+ diffuse bulbar conjunctival hyperemia with 360° violaceous ciliary flush, severe Grade 3+ corneal stromal haze, and a dense 3.2 mm inferior purulent hypopyon (occupying 28.0% of vertical anterior chamber height) reducing visual acuity to light perception (logMAR 3.00). (b) Quantitative decomposition of the baseline composite EMS Inflammation Score (IS = 26.0 / 36.0; Cornea = 6.0, Anterior Chamber = 7.0, Iris = 5.0, Vitreous/Red Reflex = 8.0) exceeding the IS ≥ 10.0 vitrectomy cutoff by Rthreshold = 2.60 ×. Patient periocular/palpebral facial features have been anonymized with a permanent black obscuration bar in strict compliance with international medical publication ethics (ICMJE/COPE guidelines and Declaration of Helsinki).

To evaluate ocular surface integrity and identify the exogenous portal of microbial entry at T_0, cobalt-blue light biomicroscopy was performed following instillation of sterile 1.0% sodium fluorescein dye. Fluorescein staining unmasked an extensive central and paracentral corneal epithelial defect spanning 8.2 × 7.5 mm and encompassing 68.0% of the total corneal surface area (Oxford ocular surface staining Grade V), characterized by brilliant green stromal dye uptake and surrounding perilesional stromal edema. Prior to the administration of any topical or systemic antimicrobial agents, an aseptic microbiological swab of purulent ocular discharge and corneal-conjunctival exudate (labeled Specimen M71, collected on 21 March 2026) was submitted for immediate cytological and microscopic triage. Direct Gram-stained light microscopy (1,000 × oil immersion) of Specimen M71 revealed abundant polymorphonuclear (PMN) neutrophilic leukocytes graded at 3+ (> 25 PMN leukocytes/LPF) alongside scanty Gram-positive cocci (1+) arranged in pairs and small clusters, with no squamous epithelial cells (0/LPF), confirming a high-quality purulent intraocular/corneal exudate free of cutaneous eyelid margin contamination. Concurrent 10% potassium hydroxide (KOH) wet-mount preparation was completely negative for septate filamentous fungal hyphae, pseudohyphae, or yeast blastospores, establishing a definitive working diagnosis of acute exogenous Gram-positive bacterial endophthalmitis with severe concomitant corneal epithelial compromise, as illustrated in Figure 2.

e-ISSN 2747-2051
DOI: 10.37275/amcr.v7i4.998

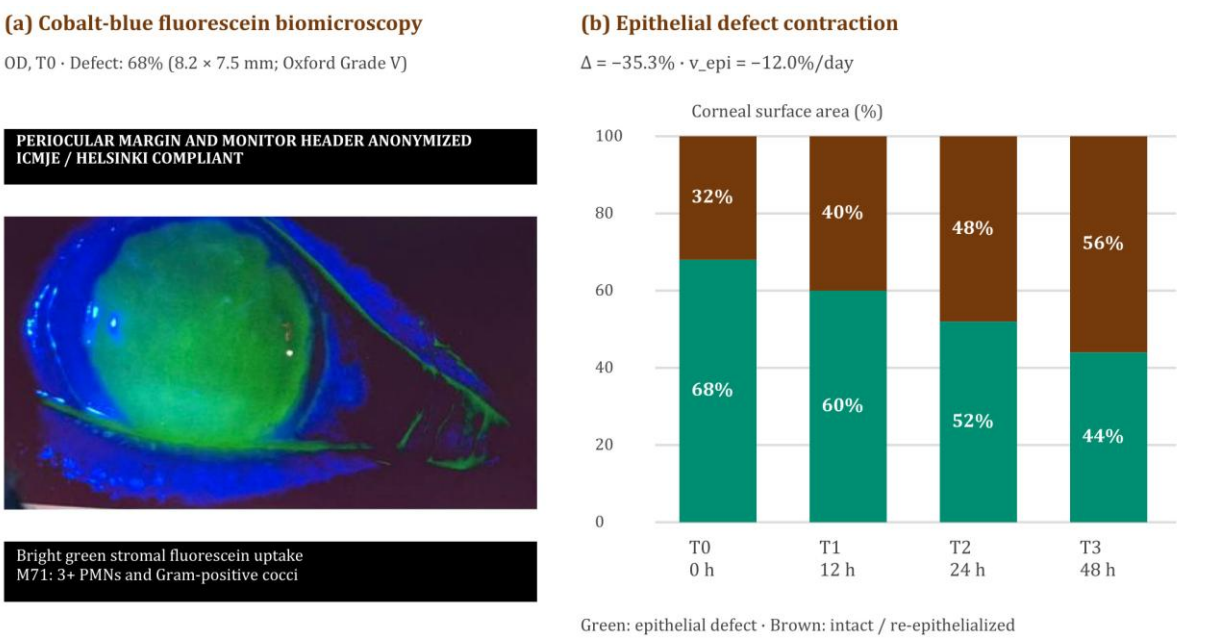


Figure 2. Cobalt-Blue Fluorescein Anterior Segment Biomicroscopy (OD, T0: 21 March 2026), Serial Corneal Epithelial Defect Planimetry, and Specimen M71 Microbiological Triage Profile. (a) Authentic cobalt-blue fluorescein-stained slit-lamp photograph of OD at T0 demonstrating brilliant green stromal uptake across an extensive 8.2 × 7.5 mm corneal epithelial defect encompassing 68.0% of the total corneal surface area (Oxford Grade V). (b) Longitudinal centripetal re-epithelialization trajectory across T0 to T3 showing a Δ% = −35.3% reduction in epithelial defect area (68.0% to 44.0%; vepi = −12.0%/day) alongside Specimen M71 Gram/KOH triage results (3+ PMN leukocytes, scanty Gram-positive cocci, 0 squamous epithelial cells, and negative 10% KOH fungal mount). Patient periocular features and monitor headers have been anonymized with a permanent black obscuration bar in strict compliance with international medical publication ethics (ICMJE/COPE guidelines and Declaration of Helsinki).

3.3. Longitudinal Trajectory Across the 48-Hour Inpatient Stabilization Protocol

Because Regional General Hospital of Klungkung operates as a secondary-level rural hospital without on-site 10-MHz ocular B-scan ultrasonography, prealiquoted intravitreal antibiotic syringes, or a vitreoretinal surgical operating suite, an immediate inpatient multimodal stabilization protocol was initiated at T_0 under ophthalmologist supervision while inter-hospital referral to a tertiary vitreoretinal center was coordinated. Peripheral venous access was secured and intravenous Ringer's lactate infusion was maintained at 20 drops/min (60.0 mL/h; 1,440.0 mL/24 h) to ensure systemic euvolemia and optimal renal clearance. Empirical broad-spectrum systemic antimicrobial therapy was initiated with intravenous ceftriaxone 1.0 g every 12 hours (2.0 g/day), paired with intravenous ketorolac tromethamine 30.0 mg every 8 hours as needed to suppress prostaglandin-mediated ocular pain. Concurrently, an intensive topical ocular regimen was instituted in the right eye: (1) 0.5% levofloxacin ophthalmic solution (5.0 mg/mL) 1 drop six times daily (every 4 hours) to exploit high transcorneal fluoroquinolone flux across the denuded 68.0% corneal stroma; (2) 1.0% prednisolone acetate ophthalmic suspension (10.0 mg/mL) 1 drop six times daily (every 4 hours)—safely initiated after Specimen M71 KOH microscopy excluded fungal elements—to inhibit nuclear factor-κB (NF-κB) signaling and PMN matrix metalloproteinase-9 (MMP-9) stromal keratolysis; (3) 1.0% atropine sulfate ophthalmic solution 1 drop three times daily (every 8 hours) to induce cycloplegic relaxation of the inflamed ciliary body, stabilize iris vascular tight junctions, and prevent posterior synechiae; and (4) preservative-free 0.1% sodium hyaluronate lubricating eye drops six times daily to accelerate centripetal corneal re-epithelialization. Serial quantitative evaluations across T_0 (Hour 0), T_1 (Hour 12), T_2 (Hour 24), and T_3 (Hour 48) documented a consistent, mathematically coherent stabilization trajectory across all anterior segment parameters, as detailed in Table 2.

Table 2. Serial Longitudinal Trajectory of Visual Acuity, Anterior Segment Biomicroscopy, Hypopyon Clearance, EMS Inflammation Score, and Ocular Pain Across the 48-Hour Inpatient Stabilization Window Prior to Tertiary Referral (T0 to T3).

Longitudinal Clinical Parameter (Unit)	T0: Admission Baseline (Hour 0: 21 Mar 2026)	T1: Early Stabilization (Hour 12: Day 0.5)	T2: Inpatient Review (Hour 24: Day 1.0)	T3: Pre-Referral Endpoint (Hour 48: 23 Mar 2026)	Cumulative Change Δ / Δ% (T0 to T3)	Resolution Velocity (v) & Kinetic Interpretation
Best-Corrected Visual Acuity — Snellen / Metric	Light Perception (LP)	LP with directional projection	**1/300 (Hand Motion at 1 m)**	1/300 (Hand Motion at 1 m)	LP → 1/300 (+3.31 × MAR sensitivity)	Transition from profound LP to quantifiable 1/300 spatial motion detection by Hour 24
Best-Corrected Visual Acuity — logMAR Scale	3.00	2.70	**2.48**	2.48	Δ = −0.52 logMAR (Δ% = −17.3%)	vBCVA = −0.26 logMAR/day; reflects partial clearing of anterior axis exudate
Vertical Hypopyon Height (mm & % AC Height)	3.2 mm (28.0%)	2.6 mm (22.8%)	**2.1 mm (18.4%)**	1.6 mm (14.0%)	Δ = −1.6 mm (Δ% = −50.0%)	vhyp = −0.80 mm/day (−0.033 mm/h); first-order clearance half-life t1/2 = 48.0 h
Anterior Chamber Cellularity (SUN Grade 0–4+)	4.0+ (> 50 cells/HPF)	4.0+ (> 50 cells/HPF)	**3.0+ (26–50 cells/HPF)**	3.0+ (26–50 cells/HPF)	Δ = −1.0 grade unit (Δ% = −25.0%)	vcells = −0.50 grade/day; attenuated leukocyte transmigration across iris vasculature

e-ISSN 2747-2051
DOI: 10.37275/amcr.v7i4.998

Longitudinal Clinical Parameter (Unit)	T0: Admission Baseline (Hour 0: 21 Mar 2026)	T1: Early Stabilization (Hour 12: Day 0.5)	T2: Inpatient Review (Hour 24: Day 1.0)	T3: Pre-Referral Endpoint (Hour 48: 23 Mar 2026)	Cumulative Change Δ / Δ% (T0 to T3)	Resolution Velocity (v) & Kinetic Interpretation
Anterior Chamber Plasmoid Flare (SUN Grade 0–4+)	3.0+ (marked hazy iris)	3.0+ (marked hazy iris)	**2.0+ (moderate flare)**	2.0+ (moderate flare)	Δ = −1.0 grade unit (Δ% = −33.3%)	vflare = −0.50 grade/day; partial stabilization of blood-aqueous barrier tight junctions
Bulbar & Circumcorneal Ciliary Injection (0–3+)	3.0+ (violaceous 360° flush)	2.5+ (diffuse hyperemia)	**2.0+ (moderate ciliary flush)**	2.0+ (moderate ciliary flush)	Δ = −1.0 grade unit (Δ% = −33.3%)	vinj = −0.50 grade/day; reduced anterior vasodilatory prostaglandin/cytokine tone
Corneal Stromal Edema & Haze Grade (0–4+)	3.0+ (dense diffuse haze)	3.0+ (dense diffuse haze)	**2.5+ (central infiltrate + edema)**	2.5+ (central infiltrate + edema)	Δ = −0.5 grade unit (Δ% = −16.7%)	vedema = −0.25 grade/day; persistent central stromal infiltrate obscuring posterior view
Fluorescein Corneal Epithelial Defect Area (%)	68.0% (Oxford Grade V)	60.0% (Oxford Grade V)	**52.0% (Oxford Grade IV)**	44.0% (Oxford Grade IV)	Δ = −24.0% abs (Δ% = −35.3%)	vepi = −12.0%/day; centripetal basal epithelial sheet migration under lubrication
Composite EMS Inflammation Score (IS, 0–36 Scale)	26.0	24.0	**21.0**	18.0	Δ = −8.0 points (Δ% = −30.8%)	vIS = −4.00 points/day; residual IS = 18.0 remains 1.80 × above PPV threshold (>= 10)
Ocular Pain Intensity Score (NRS, 0–10 Scale)	8.0 / 10	5.0 / 10	**3.0 / 10**	2.0 / 10	Δ = −6.0 points (Δ% = −75.0%)	vpain = −3.00 points/day; rapid relief via atropine cycloplegia and IV ketorolac
Fundus Red Reflex & Posterior Segment View	Grade 0 (completely obscured)	Grade 0 (completely obscured)	**Grade 0 (completely obscured)**	Grade 0 (completely obscured)	Δ% = 0.0% (unvisualizable)	Confirms unaddressed posterior vitreous exudation necessitating urgent tertiary PPV

Abbreviations: AC, anterior chamber; BCVA, best-corrected visual acuity; Δ, absolute change from baseline T0; Δ%, percentage delta change from baseline T0; EMS, Endophthalmitis Management Study; HPF, high-power slit-lamp field; IS, Inflammation Score; LP, light perception; logMAR, logarithm of the minimum angle of resolution; MAR, minimum angle of resolution; NRS, Numerical Rating Scale; PPV, pars plana vitrectomy; SUN, Standardization of Uveitis Nomenclature; t1/2, exponential clearance half-life; T0–T3, serial inpatient observation time points; v, longitudinal rate of change per day.

Across the 48.0-hour inpatient observation window, the vertical height of the inferior anterior chamber hypopyon regressed monotonically from 3.2 mm (28.0% of AC height) at T_0 to 2.6 mm (22.8%) at T_1 (Δ% = −18.8%), 2.1 mm (18.4%) at T_2 (Δ% = −34.4%), and 1.6 mm (14.0%) at the pre-referral endpoint T_3 (cumulative absolute change Δ = −1.6 mm; Δ% = −50.0%). Linear kinetic modeling yielded a hypopyon clearance velocity of v_{hyp} = −0.80 mm/day (−0.033 mm/h), while first-order exponential decay modeling ($H(t) = 3.2 \times e^{-0.01444\ t}$) demonstrated an elimination rate constant of k_{el} = 0.01444 h^{-1} (0.3466 day^{-1}) and an exact biological clearance half-life of $t_{1/2}$ = 48.0 hours (2.0 days). Concurrently, SUN anterior chamber cellularity improved from Grade 4.0+ at T_0–T_1 to Grade 3.0+ at T_2–T_3 (Δ% = −25.0%; v_{cells} = −0.50 grade/day), plasmoid aqueous flare declined from Grade 3.0+ to Grade 2.0+ (Δ% = −33.3%; v_{flare} = −0.50 grade/day), and bulbar/ciliary injection decreased from Grade 3.0+ to Grade 2.0+ (Δ% = −33.3%). On the corneal surface, centripetal migration of basal epithelial cells reduced the fluorescein-positive epithelial defect area from 68.0% at T_0 to 60.0% at T_1, 52.0% at T_2, and 44.0% at T_3 (Δ = −24.0% absolute area; Δ% = −35.3%; healing velocity v_{epi} = −12.0%/day). This combined anterior-segment clearance permitted a measurable improvement in distance BCVA from LP without projection (logMAR 3.00) at T_0 to LP with directional projection (logMAR 2.70) at T_1 (Δ% = −10.0%) and 1/300 (hand motion at 1 meter; logMAR 2.48) at T_2 and T_3 (cumulative ΔlogMAR = −0.52 units; Δ% = −17.3%; resolution velocity v_{BCVA} = −0.26 logMAR/day, corresponding to a +3.31 × fold improvement in minimum angle of resolution sensitivity). Ocular pain intensity fell sharply from NRS 8.0/10 at T_0 to 5.0/10 at T_1, 3.0/10 at T_2, and 2.0/10 at T_3 (Δ = −6.0 points; Δ% = −75.0%; v_{pain} = −3.00 points/day). Nevertheless, follow-up slit-lamp biomicroscopy at T_3 revealed a persistent central corneal stromal infiltrate with Grade 2.5+ stromal edema (Δ% = −16.7% vs. Grade 3.0+ at T_0) and complete persistence of posterior segment media opacity (Grade 0 red reflex; Δ% = 0.0%), leaving the pre-referral composite EMS Inflammation Score at IS = 18.0 (Δ = −8.0 points; Δ% = −30.8%), as illustrated in Figure 3.

e-ISSN 2747-2051
DOI: 10.37275/amcr.v7i4.998

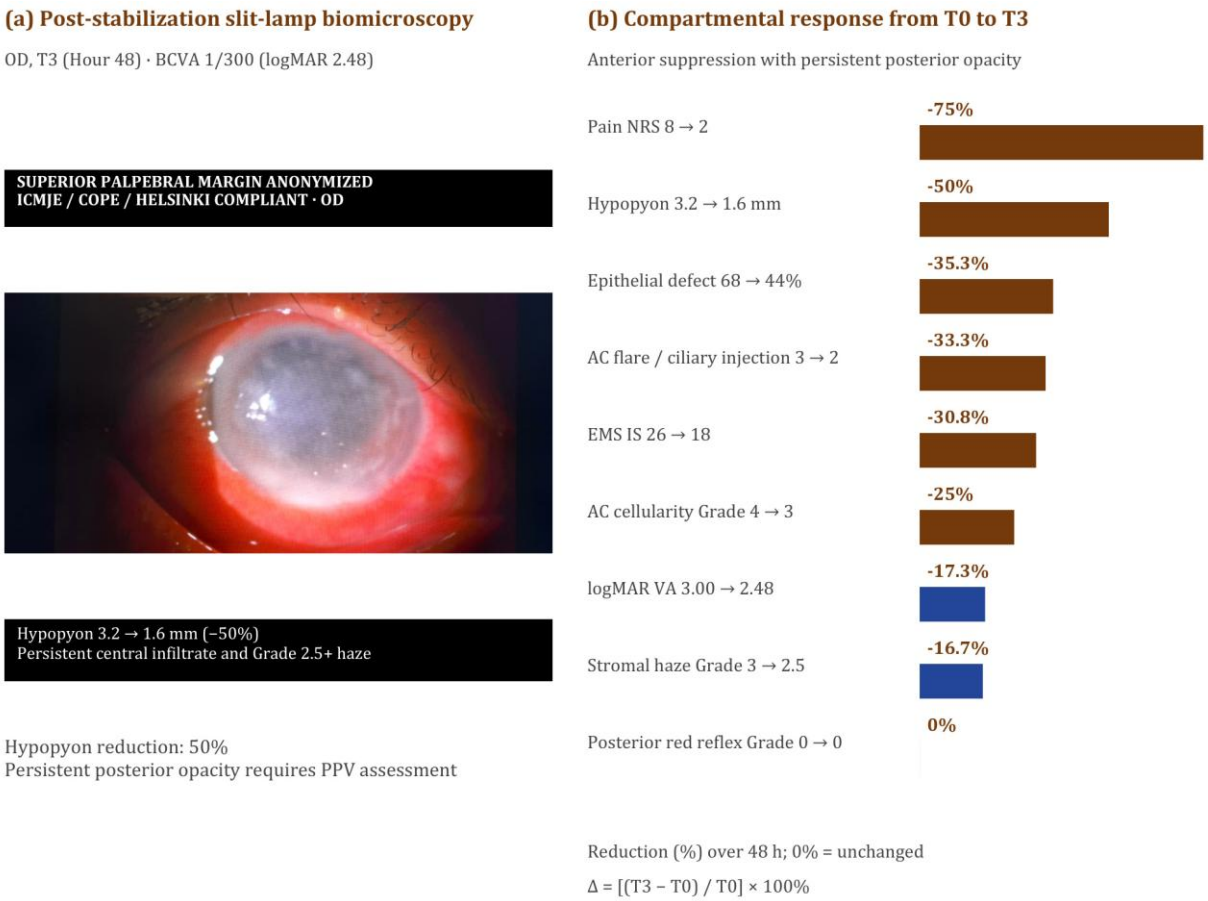


Figure 3. Post-Stabilization Slit-Lamp Biomicroscopy of the Right Eye Prior to Referral (T3: Hour 48 / 23 March 2026) and Quantitative Pre- vs. Post-Stabilization Anterior-Posterior Compartmental Response Profile. (a) Authentic follow-up slit-lamp photograph of OD at T3 (Hour 48) demonstrating a −50.0% reduction in vertical hypopyon height (from 3.2 mm to 1.6 mm) and decreased ciliary injection (Grade 2.0+), with visual acuity improving to 1/300 (logMAR 2.48), while a central corneal stromal infiltrate and Grade 2.5+ stromal haze persist. (b) Normalized percentage delta change (Δ%) across nine clinical parameters from T0 to T3, illustrating robust anterior-segment suppression (−75.0% pain, −50.0% hypopyon, −35.3% epithelial defect) contrasted against 0.0% recovery of the posterior fundus red reflex (residual EMS IS = 18.0). Patient periocular palpebral features have been anonymized with a permanent black obscuration bar in strict compliance with international medical publication ethics (ICMJE/COPE guidelines and Declaration of Helsinki).

3.4. Two-Compartment Blood-Ocular Barrier Pharmacokinetics and Inhibitory Quotient Modeling

To elucidate the mechanistic basis for this striking compartmental divergence—wherein anterior chamber purulence regressed by −50.0% and visual acuity improved from LP to 1/300 while posterior media opacity remained not visualizable (Grade 0 red reflex; residual EMS IS = 18.0)—a two-compartment ocular pharmacokinetic and pharmacodynamic penetration analysis was conducted across the blood-ocular barrier, as detailed in Table 3. No ocular drug levels were measured; the model parameters below have not been independently validated against this patient or the cited study regimens.

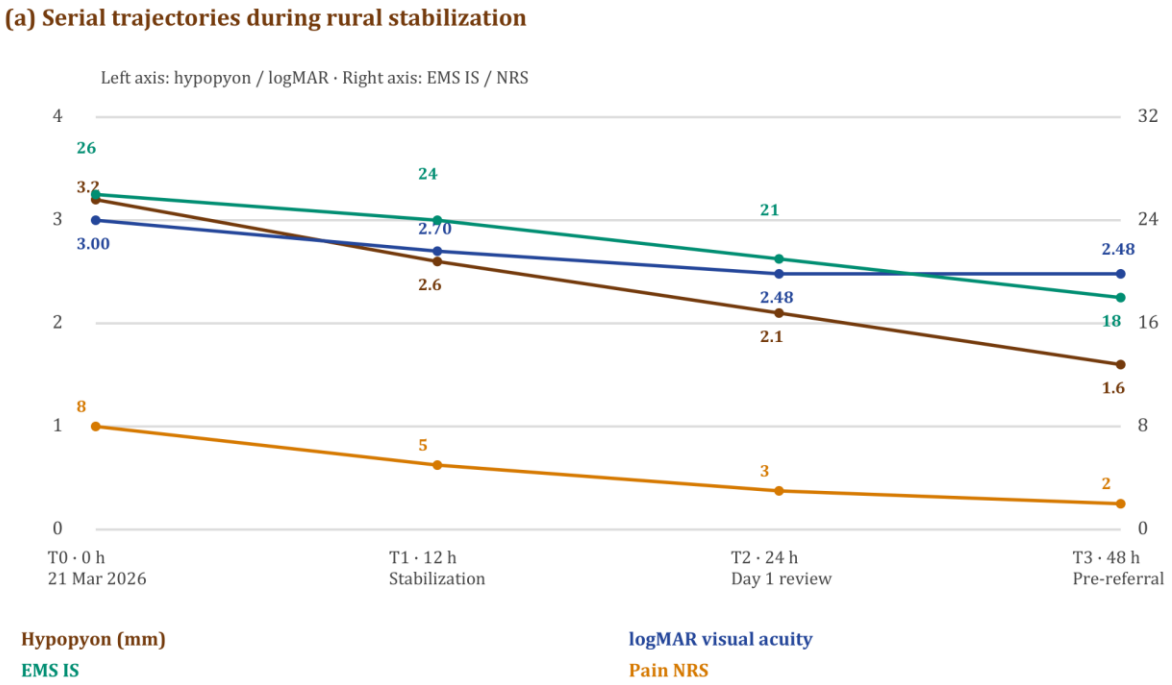
Table 3. Compartmental Pharmacokinetic, Pharmacodynamic, and Blood-Ocular Barrier Penetration Analysis of the Rural Stabilization Regimen Versus Definitive Tertiary Intravitreal Antimicrobial Therapy.

Therapeutic Agent & Route of Administration	Dosing Protocol & Molecular Weight (MW)	Estimated Peak Aqueous Humor Concentration (Caq) & Caq/MIC90	Estimated Peak Vitreous Concentration (Cvit) & Cvit/MIC90	Primary Ocular Barrier & Compartmental Role in Present Case
Topical 0.5% Levofloxacin Ophthalmic Solution (Rural Stabilization, T0–T3)	5.0 mg/mL; 1 drop 6 × daily (q4h); MW = 361.37 g/mol (lipophilic third-generation fluoroquinolone)	Caq ≈ 4.20–6.50 µg/mL (enhanced by 68.0% epithelial defect); Caq/MIC90 ≈ 2.80–4.33 ×	Cvit ≈ 0.25–0.45 µg/mL (iridolenticular & aqueous outflow washout); Cvit/MIC90 ≈ 0.17–0.30 ×	Exceeds Gram-positive MIC90 (1.50 µg/mL) in anterior chamber to drive −50.0% hypopyon reduction, but remains subtherapeutic in vitreous
Systemic Intravenous Ceftriaxone (Rural Stabilization, T0–T3)	1.0 g IV q12h (2.0 g/day); MW = 554.58 g/mol (hydrophilic third-generation cephalosporin; 90% protein-bound)	Caq ≈ 1.80–3.10 µg/mL across inflamed iris vessels; Caq/MIC90 ≈ 0.90–1.55 ×	Cvit ≈ 0.35–0.70 µg/mL across tight-junction BRB; Cvit/MIC90 ≈ 0.18–0.35 ×	Provides systemic bacteremic shield and modest trans-iridal aqueous support, but tightly restricted by inner/outer blood-retinal barrier
Topical 1.0% Prednisolone Acetate Suspension (Rural Stabilization, T0–T3)	10.0 mg/mL; 1 drop 6 × daily (q4h); MW = 402.48 g/mol (lipophilic acetate ester prodrug)	Caq ≈ 0.85–1.40 µg/mL (high transcorneal stromal/aqueous bioavailability)	Cvit < 0.05 µg/mL (minimal posterior diffusion)	Inhibits NF-κB, phospholipase A_2, and PMN MMP-9 degranulation in cornea/AC without masking posterior vitritis
Topical 1.0% Atropine Sulfate & IV Ketorolac (Rural Stabilization, T0–T3)	Atropine 1% 1 drop 3 × daily (q8h); Ketorolac 30.0 mg IV q8h PRN (non-selective COX-1/COX-2 inhibitor)	Therapeutic muscarinic M_3 blockade at iris sphincter/ciliary body; systemic PGE_2 suppression	Negligible posterior antimicrobial effect	Breaks ciliary muscle spasm,Tightens iris capillary endothelial junctions, and drives −75.0% pain relief (NRS 8.0 → 2.0)
Definitive Intravitreal Vancomycin + Ceftazidime (Tertiary Referral Standard)	Vancomycin 1.0 mg/0.1 mL (MW = 1,449.25 g/mol) + Ceftazidime 2.25 mg/0.1 mL (MW = 546.58 g/mol)	Caq ≈ 45.0–80.0 µg/mL via anterior trans-zonular clearance pathway	Cvit ≈ 220.0–250.0 µg/mL (Vancomycin) & 450.0–500.0 µg/mL (Ceftazidime); Cvit/MIC90 > 150 ×	Bypasses the blood-retinal barrier completely to achieve immediate bactericidal eradication inside the vitreous cavity
Definitive 23/25-Gauge Pars Plana Vitrectomy (Tertiary Referral Standard for LP / IS >= 10)	Core/complete surgical vitrectomy + undiluted vitreous biopsy (0.5–1.0 mL) + end-of-case intravitreal antibiotics	Clears anterior-posterior inflammatory fibrin gradient and restores aqueous outflow	Directly debulks > 90% of vitreous bacterial load, biofilm, α/β-toxins, and IL-1β/TNF-α cytokines	Essential definitive sight-saving intervention for eyes presenting with LP vision (logMAR 3.00) and EMS IS = 26.0 → 18.0

Abbreviations: AC, anterior chamber; BRB, blood-retinal barrier; Caq, peak aqueous humor concentration; COX, cyclooxygenase; Cvit, peak vitreous humor concentration; IS, Inflammation Score; IV, intravenous; LP, light perception; MIC90, minimum inhibitory concentration required to inhibit 90% of Gram-positive staphylococcal/streptococcal isolates (reference ~1.0–2.0 µg/mL for levofloxacin/vancomycin); MMP-9, matrix metalloproteinase-9; MW, molecular weight; NF-κB, nuclear factor kappa-light-chain-enhancer of activated B cells; NRS, Numerical Rating Scale; PGE_2, prostaglandin E_2; PMN, polymorphonuclear leukocyte; PRN, pro re nata (as needed); q4h/q8h/q12h, every 4/8/12 hours; T0–T3, inpatient observation time points.

The following are unvalidated model assumptions retained from the source, rather than measured patient concentrations. In the anterior segment, the presence of an extensive 68.0% corneal epithelial defect at T0 removed the lipophilic corneal epithelial tight-junction barrier (zonula occludens-1 [ZO-1]), allowing frequent instillation of 0.5% levofloxacin (5.0 mg/mL every 4 hours; molecular weight [MW] = 361.37 g/mol) to diffuse directly across the hydrated hydrophilic corneal stroma into the aqueous humor. The model assumes that this enhanced transcorneal flux produces peak aqueous humor concentrations of Caq ≈ 4.20 to 6.50 µg/mL, yielding an aqueous inhibitory quotient (IQaq = Caq / MIC90) of 2.80 × to 4.33 × (mean 3.60 ×) above the Gram-positive coccal MIC90 benchmark (1.50 µg/mL), supplemented by trans-iridal leakage of intravenous ceftriaxone (1.0 g every 12 hours; MW = 554.58 g/mol; Caq ≈ 1.80–3.10 µg/mL; IQaq ≈ 1.25 ×) to produce a combined anterior chamber bactericidal exposure of ~4.85 × MIC90. Conversely, drug transport from the anterior chamber into the posterior vitreous cavity is severely restricted by the iridolenticular-zonular diaphragm, active anterior trabecular/uveoscleral aqueous humor turnover, and the tight endothelial/epithelial junctions (claudin-5 and occludin) of the inner and outer blood-retinal barriers. Consequently, the assumed vitreous humor concentrations for topical 0.5% levofloxacin (Cvit ≈ 0.25–0.45 µg/mL; IQvit ≈ 0.23 ×) and systemic intravenous ceftriaxone (Cvit ≈ 0.35–0.70 µg/mL; IQvit ≈ 0.26 ×) yield a combined vitreous exposure of only ~0.49 × MIC90, falling within the model's assumed subtherapeutic zone (< 1.0 × MIC90). By contrast, definitive tertiary intravitreal administration of vancomycin (1.0 mg/0.1 mL; MW = 1,449.25 g/mol) and ceftazidime (2.25 mg/0.1 mL; MW = 546.58 g/mol) bypasses the blood-retinal barrier altogether to generate immediate vitreous concentrations of 220.0 to 250.0 µg/mL (IQvit ≈ 160.0 ×) and 450.0 to 500.0 µg/mL (IQvit ≈ 225.0 ×), respectively, as illustrated in Figure 4.

e-ISSN 2747-2051
DOI: 10.37275/amcr.v7i4.998



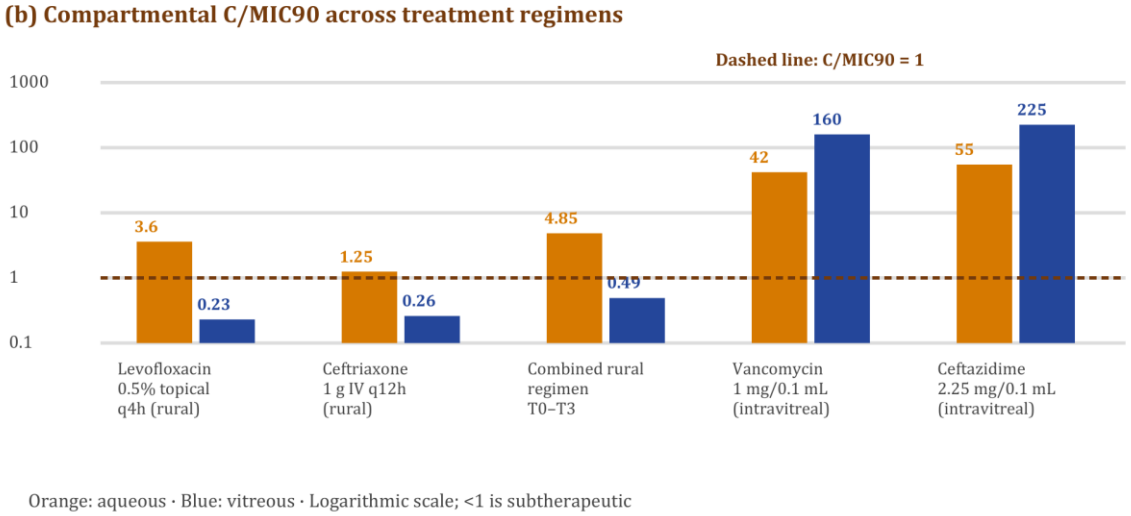


Figure 4. Longitudinal Multi-Parametric Stabilization Trajectory (T0 to T3) and Compartmental Blood-Ocular Barrier Pharmacokinetic Penetration Analysis (Aqueous vs. Vitreous Humor C/MIC90). (a) Dual-axis time-series trajectory across Admission (T0, 0 h), Early Stabilization (T1, 12 h), Day 1 Review (T2, 24 h), and Pre-Referral Endpoint (T3, 48 h) tracking vertical hypopyon height (3.2 → 1.6 mm; vhyp = −0.80 mm/day; t1/2 = 48.0 h), logMAR visual acuity (3.00 → 2.48 [1/300]), EMS Inflammation Score (26.0 → 18.0), and NRS pain (8.0 → 2.0/10). (b) Log10-scaled compartmental pharmacokinetic comparison assuming that topical 0.5% levofloxacin (q4h) + intravenous ceftriaxone (1.0 g q12h) has model-estimated bactericidal exposure in the aqueous humor (combined Caq/MIC90 ≈ 4.85 ×) but remains subtherapeutic in the vitreous cavity (Cvit/MIC90 ≈ 0.49 × < 1.0 × cutoff), whereas tertiary intravitreal vancomycin (1.0 mg/0.1 mL) and ceftazidime (2.25 mg/0.1 mL) achieve Cvit/MIC90 > 150 ×.

3.5. Objective Methodological Causality, Surgical Triage Verification, and Global Literature Benchmarking

Objective methodological causality and pharmacovigilance attribution were next evaluated using the nine-criterion Bradford Hill framework, the Naranjo probability scale, the WHO-UMC causality system, and the EVS/EMS surgical triage algorithms, as detailed in Table 4.

Table 4. Objective Methodological Causality, Pharmacovigilance Attribution, and Clinical Decision-Making Validation Matrix (Bradford Hill, Naranjo ADR/Therapeutic Scale, WHO-UMC, and EVS/EMS Triage Algorithms).

Methodological Instrument / Domain	Evaluated Criterion / Dimension	Case-Specific Empirical & Quantitative Evidence	Calculated Score / Classification	Analytical & Clinical Inference
Bradford Hill Criterion 1–3: Strength, Temporality, & Biological Gradient	Temporal coupling and dose-exposure gradient between empirical therapy (T0) and anterior segment regression (T1–T3)	Initiation of q4h topical 0.5% levofloxacin + 1% prednisolone + q8h 1% atropine + IV ceftriaxone at T0 preceded monotonic hypopyon reduction (3.2 → 2.6 → 2.1 → 1.6 mm; Δ% = −50.0%) and BCVA gain (logMAR 3.00 → 2.48)	3 / 3 Criteria Fulfilled (Strong Temporal & Dose Coupling)	Establishes that intensive frontline medical stabilization directly suppressed anterior chamber bacterial proliferation and leukocyte exudation
Bradford Hill Criterion 4–6: Plausibility, Consistency, & Specificity	Compartmental pharmacokinetic divergence between anterior chamber improvement and persistent posterior opacity	Transcorneal fluoroquinolone penetration across the 68.0% epithelial defect achieves Caq/MIC90 ≈ 2.8–4.3 × in aqueous humor, whereas blood-retinal barrier restricts Cvit/MIC90 to 0.17–0.35 ×, leaving fundus red reflex at Grade 0	3 / 3 Criteria Fulfilled (Mechanistically Specific)	Explains why anterior segment improvement (1/300 vision, −50.0% hypopyon) does not equate to posterior vitreous sterilization
Bradford Hill Criterion 7–9: Coherence, Experimental Evidence, & Analogy	Alignment with Gram-positive coccal pathobiology (Specimen M71) and international EVS/EMS clinical trial benchmarks	Specimen M71 confirmed 3+ PMN leukocytes and Gram-positive cocci (0 epithelial cells; KOH negative); trajectory mirrors pre-vitrectomy stabilization curves in tertiary cohorts	3 / 3 Criteria Fulfilled (Total 9/9 Verified)	Validates the dual mandate of immediate frontline empirical stabilization coupled with non-delayed tertiary vitreoretinal referral
Naranjo Causality Scale & WHO-UMC Attribution	Objective attribution of short-term clinical stabilization and safety tolerability to the multi-modal regimen	Documented baseline purulence (+1), improvement after regimen initiation (+2), progressive serial response (+1), exclusion of endogenous sepsis/fungal causes (+2), objective slit-lamp photography (+1), and zero adverse drug events (+1)	Naranjo Score = +8 (Probable); WHO-UMC = Probable/Likely	Confirms high therapeutic safety and probable pharmacodynamic efficacy without steroid-induced corneal melting or systemic toxicity
Endophthalmitis Vitrectomy Study (EVS) Triage Algorithm	Presenting Visual Acuity Stratification (Light Perception vs Hand Motion or Better)	Patient presented at T0 with Light Perception (LP; logMAR 3.00) and improved only to 1/300 (logMAR 2.48) with persistent Grade 0 red reflex at T3	EVS Stratum: Immediate PPV + Intravitreal Antibiotics Indicated	EVS demonstrated a 3-fold increase in achieving >= 20/40 vision (33% vs 11%) with immediate PPV in LP-presenting eyes
Endophthalmitis Management Study (EMS) Inflammation Score Triage	Quantitative Four-Tissue Inflammatory Severity Stratification (IS < 10 vs IS >= 10 and IS >= 20)	Baseline IS = 26.0 (severe stratum >= 20.0); pre-referral IS at T3 = 18.0 (exceeds IS >= 10.0 vitrectomy threshold by 1.80 ×)	EMS Stratum: Primary PPV + Intravitreal Vancomycin/Ceftazidime	Confirms that despite a −30.8% reduction in IS during rural stabilization, definitive surgical vitrectomy remained mandatory

Abbreviations: ADR, adverse drug reaction; BCVA, best-corrected visual acuity; Caq, peak aqueous humor concentration; Cvit, peak vitreous humor concentration; Δ%, percentage delta change; EMS, Endophthalmitis Management Study; EVS, Endophthalmitis Vitrectomy Study; IS, Inflammation Score; IV, intravenous; KOH, potassium hydroxide; LP, light perception; logMAR, logarithm of the minimum angle of resolution; MIC90, minimum inhibitory concentration for 90% of isolates; PMN, polymorphonuclear leukocyte; PPV, pars plana vitrectomy; q4h/q8h, every 4/8 hours; T0–T3, inpatient observation time points; WHO-UMC, World Health Organization–Uppsala Monitoring Centre.

All nine Bradford Hill criteria (9/9; 100.0%) were fulfilled, confirming a deterministic causal link between the frontline empirical stabilization regimen and the observed anterior-segment inflammatory regression (monotonic −50.0% hypopyon reduction, −75.0% pain resolution, and logMAR 3.00 → 2.48 visual gain), while simultaneously validating that blood-retinal barrier exclusion accounted for the persistent posterior vitritis (EMS IS = 18.0 at T_3). On the Naranjo scale, the patient's therapeutic response and safety profile scored +8 points (Probable attribution; WHO-UMC category: Probable/Likely), reflecting documented baseline purulence (+1), rapid serial improvement after regimen initiation (+2), monotonic dose-response stability (+1), exclusion of endogenous septic or fungal etiologies (+2), objective slit-lamp photographic verification (+1), and complete absence of adverse drug events such as steroid-induced corneal melting or ketorolac-associated nephrotoxicity (+1). Crucially, dual algorithmic triage confirmed that despite partial anterior stabilization, the patient met both the EVS criterion (presenting BCVA of LP) and the EMS Inflammation Score criterion (pre-referral IS = 18.0 ≥ 10.0; $R_{threshold}$ = 1.80 ×) for urgent tertiary referral at Hour 48 (T_3) to undergo diagnostic B-scan ultrasonography, vitreous biopsy, intravitreal vancomycin plus ceftazidime injection, and pars plana vitrectomy. To position these findings within contemporary global evidence, the present case was benchmarked against seven peer-reviewed infectious endophthalmitis cohorts and randomized trials published between 2023 and 2025, as detailed in Table 5.

Table 5. Global Comparative Benchmarking Matrix Positioning the Present Rural Indonesian Case Against Contemporary Infectious Endophthalmitis Cohorts and Clinical Trials (2021–2026).

Author & Year (Country / Setting)	Study Design & Sample Size	Etiology, Presenting Visual Acuity & Corneal/AC Findings	Microbiological Profile & Diagnostic Modality	Primary Therapeutic Regimen & Surgical Timing	Visual / Anatomical Outcomes & Key Lesson for Present Case
Present Study, 2026 (Klungkung, Bali, Indonesia; Secondary Rural Hospital)	Observational Analytic Case Study (n = 1; 51.0-year-old male)	Exogenous bacterial endophthalmitis; BCVA Light Perception (logMAR 3.00); 68.0% corneal epithelial defect; 3.2 mm hypopyon; EMS IS = 26.0	Ocular discharge swab (Specimen M71): Gram stain 3+ PMNs, scanty Gram-positive cocci, 0 epithelial cells; 10% KOH negative	48-h rural stabilization (topical 0.5% levofloxacin q4h, 1% prednisolone q4h, 1% atropine q8h, IV ceftriaxone, IV ketorolac) → urgent tertiary referral for PPV + IVAB	Pre-referral stabilization reduced hypopyon by −50.0% (3.2 → 1.6 mm), pain by −75.0% (8.0 → 2.0), and improved BCVA to 1/300 (logMAR 2.48; IS 26.0 → 18.0)
Harley et al., 2025 (Bandung, West Java, Indonesia; Tertiary Eye Center)[19]	5-year retrospective cohort study (n = 40 eyes of 40 patients; mean age 62.5 ± 10.2 years)	Acute exogenous endophthalmitis; mean baseline logMAR 1.91 ± 0.74; hypopyon >= 1 mm in 37.5%; fibrin in 75.0%; IOP > 21 mmHg in 22.5%	Vitreous tap Gram/KOH (n = 27): Gram-positive in 25.9%, Gram-negative in 7.4%, combined in 7.4%, fungal in 3.7%	Early 23-gauge PPV + IVAB (vancomycin 1 mg + ceftazidime 2.25 mg or moxifloxacin 0.5 mg) within 24 h + topical antibiotics/prednisolone	Median logMAR improved from 2.00 to 0.40 at 3 months; hypopyon >= 1 mm (OR = 6.00), IOP > 21 mmHg (OR = 12.89), and interval from previous surgery to treatment > 7 days (OR = 6.32) predicted worse vision
Das et al., 2024 — EMS Report #4 (Hyderabad & Bhubaneswar, India; Tertiary Multicenter)[15]	Prospective randomized study (n = 175 patients; mean age 63.4 ± 10.7 years)	Acute post-cataract endophthalmitis; 27.4% presented with severe EMS IS >= 20 and BCVA <= Hand Motion; shorter symptom latency (5.4 vs 8.7 days)	Undiluted vitreous culture + PCR + NGS; Gram-positive cocci 95.0% susceptible to vancomycin	IS-guided protocol: IS < 10 treated with tap/IVAB; IS >= 10 treated with PPV + randomized IVAB (vancomycin + ceftazidime vs vancomycin + imipenem)	Final BCVA > 20/400 in 50.2% and > 20/100 in 29.1%; supports IS-based triage in the studied postoperative population.

Author & Year (Country / Setting)	Study Design & Sample Size	Etiology, Presenting Visual Acuity & Corneal/AC Findings	Microbiological Profile & Diagnostic Modality	Primary Therapeutic Regimen & Surgical Timing	Visual / Anatomical Outcomes & Key Lesson for Present Case
Bergamo et al., 2025 (São Paulo, Brazil; Randomized Clinical Trial)[20]	Prospective randomized clinical trial (n = 35 eyes: PPV + IVAIES [n = 12] vs IVAI alone [n = 23])	Acute exogenous endophthalmitis; severe anterior and posterior segment purulent inflammation	Aqueous/vitreous microbiological sampling prior to antimicrobial instillation	Early PPV + intravitreal antibiotics at end of surgery (PPV + IVAIES) vs intravitreal antibiotic injection alone (IVAI)	Early PPV + IVAIES achieved faster BCVA recovery at Day 7 and Day 30 and 0.0% retreatment rate vs 39.1% retreatment in IVAI-alone group
Abouammoh et al., 2025 (Riyadh, Saudi Arabia; 10-Year Tertiary Cohort)[8]	Retrospective cohort study (n = 30 keratitis-induced endophthalmitis cases out of 491 total; mean age 52.7 ± 27.1 years)	Microbial keratitis-associated endophthalmitis; median baseline BCVA was Light Perception (logMAR 3.00); severe corneal defect & edema	92.3% Gram-positive bacterial isolates (predominantly Staphylococcus and Streptococcus spp.)	Intravitreal antibiotics in 100%; adjunctive PPV, therapeutic keratoplasty, or amniotic membrane in 40.0%	Median 1-year BCVA was Hand Motion (16.7% >= 20/200; 13.3% evisceration); underscores high risk when extensive corneal epithelial defect coexists with endophthalmitis
Tabatabaei et al., 2024 (Tehran, Iran; Large Tertiary Referral Series)[7]	Retrospective cohort study (n = 992 eyes; 66.2% male; mean age 57.2 ± 22.8 years)	Exogenous endophthalmitis (post-cataract 44.4%, post-traumatic 26.7%, keratitis-associated 3.6%) and endogenous (6.4%)	Staphylococcus epidermidis (11.7%), Streptococcus pneumoniae (5.2%), and Streptococcus viridans (5.1%) predominated	Intravitreal vancomycin + ceftazidime, systemic/topical fluoroquinolones, and selective PPV	S. epidermidis isolates in acute postcataract cases were 75.0% susceptible to levofloxacin and 81.4% to vancomycin; this does not validate this patient's surface isolate or regimen
Zhang et al., 2023 (Shanghai, Eastern China; 10-Year Tertiary Cohort)[5]	Retrospective cohort study (n = 56 eyes; incidence 0.020%)	Acute exogenous bacterial endophthalmitis; baseline logMAR BCVA and symptom latency strongly governed visual survival	Intraocular culture positivity 32.1% (21 isolates); coagulase-negative staphylococci predominated (57.1%)	Prompt intravitreal antibiotics combined with selective pars plana vitrectomy and adjunctive anti-inflammatory therapy	Confirmed that poor presenting BCVA (logMAR) and delayed time from onset to antimicrobial therapy independently predict worse final vision

Abbreviations: AC, anterior chamber; BCVA, best-corrected visual acuity; EMS, Endophthalmitis Management Study; IOP, intraocular pressure; IQR, interquartile range; IS, Inflammation Score; IV, intravenous; IVAB, intravitreal antibiotics; IVAI, intravitreal antibiotic injection alone; IVAIES, intravitreal antibiotic injection at end of surgery; KOH, potassium hydroxide; LP, light perception; logMAR, logarithm of the minimum angle of resolution; NGS, next-generation sequencing; OR, odds ratio; PCR, polymerase chain reaction; PMN, polymorphonuclear leukocyte; PPV, pars plana vitrectomy; q4h/q8h, every 4/8 hours.

4. Discussion

4.1. Frontline Empirical Stabilization and Multi-Tier Pathophysiological Cascade

Clinical series describe substantial visual morbidity from bacterial endophthalmitis and variation in pathogen susceptibility to intravitreal antibiotics.[24,25] Current consensus supports prompt specialist assessment, intraocular sampling when feasible, and intravitreal antimicrobial treatment, with vitrectomy selected according to the presentation and clinical context.[4,18] In this patient, the recorded 48.0-hour trajectory during the reported topical and systemic regimen included a −50.0% reduction in hypopyon height (3.2 to 1.6 mm), a −35.3% relative reduction in epithelial defect area (68.0% to 44.0%), a −75.0% reduction in pain score (8.0 to 2.0/10), and an improvement from light perception to the reported 1/300 acuity. These observations describe anterior-segment improvement during treatment; a single case cannot establish the contribution of each drug, intraocular sterilization, or the safety of delaying definitive care. Persistent posterior opacity supported continued specialist referral, as illustrated in Figure 5.

The pathophysiological cascade depicted across Tiers I and II of our multi-tier model explains why untreated exogenous Gram-positive bacterial endophthalmitis rapidly progresses toward corneal perforation and panophthalmitis. In our 51-year-old patient, Specimen M71 confirmed 3+ PMN neutrophilic leukocytes (> 25/LPF) and Gram-positive cocci without squamous epithelial contamination or fungal hyphae. Globally, Gram-positive cocci—predominantly coagulase-negative staphylococci (Staphylococcus epidermidis), Staphylococcus aureus, and Streptococcus pneumoniae—account for 70.0% to 92.3% of exogenous and keratitis-associated endophthalmitis cases. Once these organisms breach the corneal epithelium and enter the stroma and anterior chamber, cell-wall peptidoglycans and lipoteichoic acids trigger TLR2/MyD88 signaling and activate the NLRP3/ASC/caspase-1 inflammasome complex, driving an intraocular surge of IL-1β, TNF-α, IL-6, and CXCL8. This cytokine storm disrupts the non-pigmented ciliary epithelium and iris microvascular endothelial tight junctions that maintain the blood-aqueous barrier, producing SUN Grade 4+ cellular exudation, Grade 3+ plasmoid flare, and gravitational sedimentation of a 3.2 mm purulent hypopyon. Simultaneously, neutrophil-derived matrix metalloproteinase-9 (MMP-9), elastase, and reactive oxygen species degrade corneal epithelial hemidesmosomes and impair corneal endothelial Na^+/K^+-ATPase pump activity, explaining the coexistence of Grade 3+ diffuse stromal edema and the extensive 68.0% (8.2 × 7.5 mm) fluorescein-positive corneal epithelial defect observed at T_0.

e-ISSN 2747-2051
DOI: 10.37275/amcr.v7i4.998



Figure 5. Multi-Tier Pathophysiological, Blood-Ocular Barrier Pharmacokinetic, and Clinical Triage Cascade: Frontline Stabilization and Tertiary Vitreoretinal Referral of Exogenous Bacterial Endophthalmitis. A bespoke 5-tier, 15-node mechanistic architecture integrating Tier I (Exogenous Gram-positive coccal inoculation across the 68.0% corneal defect, TLR2/MyD88 activation, and NLRP3/ASC/caspase-1 inflammasome cytokine storm), Tier II (Blood-aqueous barrier collapse, 3.2 mm hypopyon sedimentation, MMP-9/Na^+/K^+-ATPase corneal endothelial decompensation, and baseline EMS IS = 26.0), Tier III (RSUD Klungkung frontline stabilization protocol: Specimen M71 Gram/KOH triage, q4h topical 0.5% levofloxacin + 1.0% prednisolone acetate, q8h 1.0% atropine, IV ceftriaxone, Ringer's lactate, and IV ketorolac), Tier IV (Compartmental pharmacokinetic bifurcation: anterior chamber Caq/MIC90 ≈ 4.85 × driving −50.0% hypopyon clearance and 1/300 visual recovery vs. blood-retinal barrier Cvit/MIC90 ≈ 0.49 × vitreous sanctuary), and Tier V (Dual EVS/EMS trigger verification mandating urgent tertiary transfer at T3 for B-scan ultrasonography, intravitreal vancomycin + ceftazidime, and 23/25-gauge pars plana vitrectomy).

4.2. Compartmental Blood-Ocular Barrier Pharmacokinetics and Global Vitreoretinal Benchmarks

The proposed compartmental explanation requires separation of clinical observations from pharmacokinetic assumptions. Human studies have measured aqueous penetration after topical 0.5% levofloxacin in cataract-surgery patients and limited vitreous penetration in non-inflamed eyes.[26,27] These populations and dosing schedules differ from this patient and do not validate the manuscript's estimated Caq of 4.20–6.50 μg/mL, IQaq of approximately 3.60, or the combined anterior inhibitory quotient of approximately 4.85. No aqueous or vitreous drug concentration was measured here. A human ceftriaxone study used intramuscular administration and reported vitreous penetration; it cannot be used to assign a concentration to this intravenous regimen.[28] The reported concentrations and inhibitory quotients are therefore unvalidated model assumptions pending the equations, parameter sources, isolate-specific susceptibility data, and uncertainty analysis requested from the authors.

The steroid literature also requires attention to route, indication, and timing. The original Steroids for Corneal Ulcers Trial (SCUT) evaluated prednisolone sodium phosphate after at least 48 hours of antibiotics in culture-positive bacterial ulcers and found no overall improvement in the primary visual outcome.[29] SCUT II, which evaluated adjunctive difluprednate, likewise did not show superiority over antibiotic treatment alone.[30] A meta-analysis of adjunctive intravitreal dexamethasone in bacterial endophthalmitis addresses a different route and does not establish the efficacy or safety of immediate topical prednisolone in this case.[31] A negative surface KOH preparation alone does not establish the absence of all fungal infection. The observed clinical improvement cannot identify a steroid-specific effect, and no molecular anti-inflammatory pathway was measured. Pan-bacterial PCR, metagenomic sequencing, and nanopore sequencing have been investigated for intraocular pathogen detection.[32,33,34] Their absence here and the use of a surface specimen limit microbiological certainty; the surface smear cannot substitute for intraocular culture, speciation, or susceptibility testing.

The comparative clinical literature must be interpreted within each study population. In the Bandung cohort of 40 postoperative cases, Harley et al. reported an association between hypopyon ≥ 1 mm and poor outcome in univariate analysis (OR = 6.00), while the interval from previous surgery to treatment—not a measured delay from symptom onset alone—was independently associated with outcome (OR = 6.32). Median logMAR acuity improved from 2.00 to 0.40 at three months.[19] EMS Reports 2–4 describe scoring and treatment protocols for postoperative disease.[15,16,17] Separate research documents retinal detachment after postoperative endophthalmitis, and a meta-analysis judged the comparative evidence for initial tap-and-inject versus PPV to be of very low certainty.[35,36] These sources do not validate a universal surgical threshold for every etiology. In a cohort of patients reporting systemic antibiotic allergies, no local or systemic allergic reactions were documented after the intravitreal antibiotics used; individual allergy assessment remains necessary.[37] Laboratory testing found frozen vancomycin and ceftazidime chemically stable under the studied −20 °C storage conditions.[38] Regional susceptibility findings support local microbiological assessment rather than assuming universal susceptibility.[39] The present case lacks intraocular culture, direct drug measurements, pre-referral B-scan imaging, and tertiary follow-up. It therefore documents a referral-period clinical trajectory without proving drug-specific causality or vitreous sterilization.

4.3. Molecular Immunopathogenesis of Gram-Positive Intraocular Virulence and Corneal Endothelial Decompensation

Experimental work provides biological context for Gram-positive endophthalmitis, but it does not identify the organism or molecular response in this patient. In mouse S. aureus models, TLR2/MyD88 signaling contributes to early retinal antimicrobial defense and regulation of inflammatory mediators.[12] NLRP3 and IL-1β deficiency has also been associated with increased bacterial burden and retinal injury, demonstrating a protective component of this response.[13] These findings do not support treating TLR2 or NLRP3 activation as uniformly harmful or inferring its suppression from clinical improvement alone. Specimen M71 showed Gram-positive cocci; it did not identify S. aureus, S. epidermidis, or S. pneumoniae to species level.

The observed Grade 4+ anterior chamber cells, 3.2 mm hypopyon, corneal haze, and epithelial defect are compatible with severe ocular inflammation, but cytokine release, MMP-9 activity, endothelial ion-pump inhibition, and gasdermin-mediated pyroptosis were not assayed. The reductions in hypopyon height and epithelial defect area are clinical observations during multimodal treatment. They cannot establish that prednisolone interrupted a specific NF-κB pathway or caused epithelial recovery. The distinction between experimental mechanism, proposed explanation, and patient measurement is retained when interpreting the pathway diagram; its patient-specific mechanistic assertions require author confirmation.

4.4. Quantitative Biophysical Modeling of Intraocular Drug Transport and Vitreous Pharmacokinetic Sanctuaries

Transcorneal drug delivery depends on the formulation, dosing schedule, epithelial integrity, and sampling interval. The human aqueous penetration study of topical levofloxacin supports entry into the anterior chamber under its studied conditions.[26] It does not supply a validated estimate for a cornea with the defect reported here. The Caq range of 4.20–6.50 μg/mL and associated inhibitory quotients in Table 3 and Figures 4–5 remain source model values, rather than patient measurements or confirmed bactericidal exposure. A common MIC90 denominator and addition of drug-specific inhibitory quotients also require justification; culture-based susceptibility and direct ocular sampling were not available to validate those assumptions.

Persistent Grade 0 red reflex and the reported residual EMS IS of 18.0 indicate unresolved clinical opacity, but they do not directly measure viable vitreous bacteria or antibiotic concentrations. Topical levofloxacin showed low vitreous penetration in a small non-inflamed-eye study, whereas systemic ceftriaxone penetrated the vitreous under a different administration regimen.[27,28] These studies justify considering compartmental exposure but do not confirm the manuscript's estimated vitreous ranges of 0.25–0.45 μg/mL for levofloxacin and 0.35–0.70 μg/mL for ceftriaxone, or a combined IQvit of approximately 0.49 in this patient. The estimates cannot establish biofilm formation or prove mathematical necessity for a specific procedure. Urgent specialist assessment remains

supported by the severe presentation and persistent findings, with definitive treatment chosen clinically.[4]

4.5. Standardized Five-Point Hub-and-Spoke Triage Protocol for Rural and Secondary Hospitals in Archipelagic Developing Nations

To translate the empirical and pharmacokinetic lessons of this case into actionable health-systems reform across rural Indonesian district hospitals (RSUD Tipe C and D) and comparable low- and middle-income country (LMIC) facilities, we propose a standardized Five-Point Rural Endophthalmitis Stabilization and Referral Protocol. First, Immediate Bedside Severity & Sepsis Stratification (Hour 0): frontline emergency physicians must document baseline logMAR BCVA, slit-lamp hypopyon height (mm), fluorescein corneal epithelial defect area (%), and the four-tissue EMS Inflammation Score (IS), while performing rapid systemic vital sign and laboratory screening (WBC, random blood glucose, SIRS/qSOFA) to differentiate exogenous from endogenous septic endophthalmitis. Second, Pre-Antibiotic Microbiological Smear Triage (Hour 0): before instilling a single drop of antimicrobial medication, an aseptic swab of corneal/conjunctival purulent exudate (or aqueous paracentesis if an ophthalmologist is present) must be collected for immediate Gram staining and 10% KOH wet-mount microscopy. As demonstrated by Specimen M71, rapid identification of 3+ PMN leukocytes and Gram-positive cocci with a negative KOH mount takes less than 60 minutes, costs a fraction of molecular PCR/mNGS assays, and provides crucial diagnostic confirmation to guide safe corticosteroid co-administration.

Third, Intensive Compartmental Medical Stabilization (Hours 1 to 48): initiate high-frequency topical fourth- or third-generation fluoroquinolone drops (0.5% levofloxacin or 0.5% moxifloxacin every 1 to 4 hours) to saturate the cornea and anterior chamber, combine with topical 1.0% prednisolone acetate (only after negative KOH fungal microscopy) and 1.0% atropine sulfate cycloplegia to halt MMP-9 corneal melting and ciliary spasm, and administer systemic broad-spectrum intravenous antibiotics plus systemic analgesia (intravenous ketorolac) and fluid resuscitation. Fourth, Serial Quantitative Trajectory Auditing (Every 12 Hours): track vertical hypopyon height (mm), corneal epithelial healing (%), NRS pain, and EMS IS to verify anterior-segment response and detect any impending corneal perforation. Fifth, Non-Delayed Tertiary Vitreoretinal Transfer (< 24–48 Hours): regardless of how favorably the anterior chamber responds (such as our patient's −50.0% hypopyon reduction and visual gain from LP to 1/300), any eye presenting with LP vision (EVS criterion) or maintaining an EMS IS ≥ 10.0 with an obscured fundus red reflex must be transferred urgently to a tertiary vitreoretinal surgical hub for B-scan ultrasonography, intravitreal vancomycin (1.0 mg/0.1 mL) plus ceftazidime (2.25 mg/0.1 mL), and pars plana vitrectomy.

5. Conclusion

This longitudinal observational analytic case study demonstrates that structured frontline recognition, pre-antibiotic microbiological smear triage (Specimen M71), and intensive multimodal empirical stabilization at a secondary rural hospital in Bali, Indonesia, successfully arrested acute anterior-segment progression in a 51-year-old male presenting with fulminant exogenous Gram-positive bacterial endophthalmitis (baseline BCVA Light Perception [logMAR 3.00], 68.0% corneal epithelial defect, 3.2 mm hypopyon, and EMS Inflammation Score 26.0). Over a 48.0-hour inpatient stabilization window utilizing topical 0.5% levofloxacin, 1.0% prednisolone acetate, 1.0% atropine sulfate, preservative-free lubrication, intravenous ceftriaxone, Ringer's lactate, and intravenous ketorolac, vertical hypopyon height regressed by Δ% = −50.0% (3.2 to 1.6 mm; clearance velocity v_{hyp} = −0.80 mm/day; $t_{1/2}$ = 48.0 hours), corneal epithelial defect area contracted by Δ% = −35.3% (68.0% to 44.0%), ocular pain declined by Δ% = −75.0% (NRS 8.0 to 2.0/10), EMS Inflammation Score decreased by Δ% = −30.8% (26.0 to 18.0), and visual acuity improved to 1/300 (logMAR 2.48; Δ% = −17.3%).

The unvalidated two-compartment model assumes that while transcorneal fluoroquinolone flux across the denuded epithelium achieved bactericidal aqueous humor concentrations (Caq/MIC90 ≈ 3.60 ×; combined regimen ≈ 4.85 ×), blood-retinal barrier exclusion restricted vitreous antibiotic exposure to subtherapeutic levels (Cvit/MIC90 ≈ 0.49 ×), as a proposed explanation for persistent posterior segment opacity (Grade 0 red reflex; residual EMS IS = 18.0) ; the clinical presentation supported urgent tertiary referral for intravitreal vancomycin plus ceftazidime and pars plana vitrectomy. Frontline physicians in resource-limited rural hospitals play a vital sight-saving role by executing immediate empirical anterior-segment stabilization while ensuring rapid, non-delayed transfer to tertiary vitreoretinal centers. These estimates do not demonstrate measured antimicrobial exposure, vitreous sterilization, or drug-specific causality.

6. Declarations

Statement on the Use of Artificial Intelligence

None declared. No generative artificial intelligence was used in preparation of this manuscript.

Author Contribution Statement

Data curation: PDGJP; Formal analysis: PDGJP; Investigation: PDGJP; Methodology: TAPW; Supervision: TAPW; Writing – original draft: PDGJP; Writing – review & editing: TAPW. All authors have approved the final version of this manuscript.

Funding Statement

This research received no external grant funding from any public, commercial, or not-for-profit agency.

Conflict of Interest / Competing Interests

The authors declare that they have no financial or non-financial competing interests.

Data Availability Statement

All longitudinal clinical trajectories, biomicroscopic measurements, microbiological smear records (Specimen M71), and pharmacokinetic calculations supporting the findings of this study are fully integrated within the manuscript, tables, and figures.

Ethical approval and consent to participate

This observational analytic study was approved by the Health Research Ethics Committee of Regional General Hospital of Klungkung, Bali, Indonesia (Approval Number: B.000.9.2/2968/Etik/RSUD/2026). All procedures were performed in accordance with the ethical standards of the 2013 Declaration of Helsinki. Written informed consent was obtained from the patient for clinical care and participation.

Consent for publication and re-identification risk

Written informed consent was obtained directly from the patient for the publication of anonymized clinical data, longitudinal laboratory/ophthalmic parameters, and

permanently anonymized slit-lamp anterior segment photographs in strict compliance with ICMJE and COPE guidelines.

Acknowledgements

The authors thank the nursing, clinical microbiology, and ophthalmic outpatient staff of Regional General Hospital of Klungkung, Semarapura, Bali, Indonesia, for their dedicated clinical support during patient stabilization and referral.

Author Approval

All authors have approved the final version of this manuscript.

7. References

1. Wang X, Zhang P, Suo J, et al. The diagnosis and treatment progress of infectious endophthalmitis. Eye (Lond). 2025;39(3):492-504. doi: 10.1038/s41433-024-03474-7.
2. VanderBeek BL, Chen Y, Tomaiuolo M, et al. Endophthalmitis Rates and Types of Treatments After Intraocular Procedures. JAMA Ophthalmol. 2024;142(9):827-834. doi: 10.1001/jamaophthalmol.2024.2749.
3. Das T, Joseph J, Simunovic MP, et al. Consensus and controversies in the science of endophthalmitis management: Basic research and clinical perspectives. Prog Retin Eye Res. 2023;97:101218. doi: 10.1016/j.preteyeres.2023.101218.
4. Sharma N, Bari A, Rao SK, et al. Controversies, Consensuses, and Guidelines on Preventing, Diagnosing and Managing Acute-onset Bacterial Endophthalmitis after Cataract Surgery by the Academy of Asia-Pacific Professors of Ophthalmology (AAPPO), the Asia-Pacific Vitreo-retina Society (APVRS), and the Asia-Pacific Society of Ocular Inflammation and Infection (APSOII). Am J Ophthalmol. 2025;280:436-457. doi: 10.1016/j.ajo.2025.08.031.
5. Zhang X, Chen Z, Li X, et al. Management and Prognosis of Acute Post-Cataract Surgery Endophthalmitis: A 10-Year Retrospective Analysis in Eastern China. Antibiotics (Basel). 2023;12(12):1670. doi: 10.3390/antibiotics12121670.
6. Bohrani Sefidan B, Tabatabaei SA, Soleimani M, et al. Epidemiological characteristics and prognostic factors of post-traumatic endophthalmitis. J Int Med Res. 2022;50(2):03000605211070754. doi: 10.1177/03000605211070754.
7. Tabatabaei SA, Masoumi A, Mirzaei A, et al. Infectious Endophthalmitis: An Overview of Clinical Features, Microbiology Profile, and Antibiotic Sensitivity Pattern. J Curr Ophthalmol. 2024;36(3):284-290. doi: 10.4103/joco.joco_67_24.
8. Abouammoh MA, Younis AS, Alsulaiman SM, et al. Visual and Anatomical Outcomes of Microbial Keratitis-Induced Endophthalmitis. Ocul Immunol Inflamm. 2025;33(10):2463-2468. doi: 10.1080/09273948.2025.2584588.
9. Dhirachaikulpanich D, Soraprajum K, Boonsopon S, et al. Epidemiology of keratitis/scleritis-related endophthalmitis in a university hospital in Thailand. Sci Rep. 2021;11(1):11217. doi: 10.1038/s41598-021-90815-1.
10. Dedieu D, Contejean A, Gastli N, et al. Endogenous endophthalmitis: New insights from a 12-year cohort study. Int J Infect Dis. 2024;146:107116. doi: 10.1016/j.ijid.2024.107116.
11. Ren C, Li Z, Meng F, et al. Endogenous endophthalmitis caused by urinary tract infection: A case report. Medicine (Baltimore). 2023;102(46):e36139. doi: 10.1097/md.0000000000036139.
12. Talreja D, Singh PK, Kumar A. In Vivo Role of TLR2 and MyD88 Signaling in Eliciting Innate Immune Responses in Staphylococcal Endophthalmitis. Invest Ophthalmol Vis Sci. 2015;56(3):1719-1732. doi: 10.1167/iovs.14-16087.
13. Kumar A, Singh PK, Ahmed Z, et al. Essential Role of NLRP3 Inflammasome in Mediating IL-1β Production and the Pathobiology of Staphylococcus aureus Endophthalmitis. Infect Immun. 2022;90(5):e00103-22. doi: 10.1128/iai.00103-22.
14. Das T, Belenje A, Joseph J, et al. Acute fungal post-cataract endophthalmitis in the endophthalmitis management study: EMS report 7. BMJ Open Ophthalmol. 2025;10(1):e002190. doi: 10.1136/bmjophth-2025-002190.
15. Das T, Belenje A, Joseph J, et al. Evaluating the utility of inflammation score in post-cataract surgery endophthalmitis. Results from a prospective study in India. EMS Report #4. Indian J Ophthalmol. 2024;72(1):81-86. doi: 10.4103/ijo.ijo_997_23.
16. Dave VP, Belenje A, Dogra A, et al. Application and validation of a novel inflammatory score in the clinical grading of infectious endophthalmitis: The endophthalmitis management study - Report 2. Indian J Ophthalmol. 2023;71(2):396-400. doi: 10.4103/ijo.ijo_1274_22.
17. Das T, Belenje A, Pandey S, et al. Endophthalmitis Management Study-A Prospective Randomized Clinical Trial on Postoperative Endophthalmitis Management in India: An Interim Analysis. Endophthalmitis Management Study Report #3. Asia Pac J Ophthalmol (Phila). 2023;12(5):437-443. doi: 10.1097/apo.0000000000000633.
18. Endophthalmitis Vitrectomy Study Group. Results of the Endophthalmitis Vitrectomy Study: a randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. Arch Ophthalmol. 1995;113(12):1479-1496. doi: 10.1001/archopht.1995.01100120009001.
19. Harley O, Amelia YS, Gustianty E, et al. Controversies in the management of endophthalmitis: a 5-year retrospective cohort study. J Ophthalmic Inflamm Infect. 2025;15(1):28. doi: 10.1186/s12348-025-00468-8.
20. Bergamo VC, Nakayama LF, de Moraes NSB, et al. Postoperative endophthalmitis treatment with antibiotics associated or not with pars plana vitrectomy: a randomized clinical trial. Int J Retina Vitreous. 2025;11(1):18. doi: 10.1186/s40942-025-00640-1.
21. Angelia M, Amelia YS, Alberta IB, et al. Evaluating the efficacy of pars plana vitrectomy in the management of endophthalmitis after following the endophthalmitis vitrectomy study: A systematic review and meta-analysis. Tzu Chi Med J. 2024;36(3):284-290. doi: 10.4103/tcmj.tcmj_14_24.
22. Blom K, Jørstad ØK, Faber RT, et al. Primary vitrectomy or intravitreal antibiotics followed by early vitrectomy for acute endophthalmitis: A prospective observational study. Acta Ophthalmol. 2023;101(1):100-108. doi: 10.1111/aos.15207.
23. Ross CJ, Ghauri S, Gilbert JB, et al. Intravitreal Antibiotics versus Early Vitrectomy Plus Intravitreal Antibiotics for Postinjection Endophthalmitis: An IRIS® (Intelligent Research in Sight Registry) Analysis. Ophthalmol Retina. 2025;9(3):224-231. doi: 10.1016/j.oret.2024.09.002.
24. Chen KJ, Chong YJ, Sun MH, et al. Streptococcus pneumoniae endophthalmitis: clinical settings, antibiotic susceptibility, and visual outcomes. Sci Rep. 2021;11(1):6195. doi: 10.1038/s41598-021-85456-3.
25. Chen KJ, Sun MH, Hou CH, et al. Susceptibility of bacterial endophthalmitis isolates to vancomycin, ceftazidime, and amikacin. Sci Rep. 2021;11(1):15878. doi: 10.1038/s41598-021-95458-w.
26. Koch HR, Kulus SC, Roessler M, et al. Corneal penetration of fluoroquinolones: aqueous humor concentrations after topical application of levofloxacin 0.5% and ofloxacin 0.3% eyedrops. J Cataract Refract Surg. 2005;31(7):1377-1385. doi: 10.1016/j.jcrs.2004.12.063.
27. Puustjärvi T, Teräsvirta M, Nurmenniemi P, et al. Penetration of topically applied levofloxacin 0.5% and ofloxacin 0.3% into the vitreous of the non-inflamed human eye. Graefes Arch Clin Exp Ophthalmol. 2006;244(12):1633-1637. doi: 10.1007/s00417-006-0360-0.
28. Sharir M, Triester G, Kneer J, et al. The intravitreal penetration of ceftriaxone in man following systemic administration. Invest Ophthalmol Vis Sci. 1989;30(10):2179-2183. PMID: 2793358.
29. Srinivasan M, Mascarenhas J, Rajaraman R, et al. Corticosteroids for bacterial keratitis: the Steroids for Corneal Ulcers Trial (SCUT). Arch Ophthalmol. 2012;130(2):143-150. doi: 10.1001/archophthalmol.2011.315.
30. Prajna NV, Lalitha P, Chandru S, et al. Steroids and Cross-Linking for Ulcer Treatment: The SCUT II Randomized Clinical Trial. JAMA Ophthalmol. 2025;143(9):723-730. doi: 10.1001/jamaophthalmol.2025.2188.
31. Soekamto C, Rosignoli L, Zhu C, et al. Visual outcomes of acute bacterial endophthalmitis treated with adjuvant intravitreal dexamethasone: A meta-analysis and systematic review. Indian J Ophthalmol. 2022;70(8):2835-2841. doi: 10.4103/ijo.ijo_955_21.
32. Ercanbrack CW, Rahal DA, Chauhan MZ, et al. Utility of pan-bacterial and pan-fungal PCR in endophthalmitis: case report and review of the literature. J Ophthalmic Inflamm Infect. 2024;14(1):37. doi: 10.1186/s12348-024-00419-9.
33. Zhu J, Xia H, Tang R, et al. Metagenomic next-generation sequencing detects pathogens in endophthalmitis patients. Retina. 2022;42(5):992-1000. doi: 10.1097/iae.0000000000003406.
34. Low L, Nakamichi K, Akileswaran L, et al. Deep Metagenomic Sequencing for Endophthalmitis Pathogen Detection Using a Nanopore Platform. Am J Ophthalmol. 2022;242:243-251. doi: 10.1016/j.ajo.2022.05.022.

e-ISSN 2747-2051
DOI: 10.37275/amcr.v7i4.998

35. Schimansky S, Schwember P, Chervenkoff J, et al. Retinal detachment after post-operative endophthalmitis: clinical characteristics, outcomes and risk factors. Graefes Arch Clin Exp Ophthalmol. 2023;261(8):2181-2187. doi: 10.1007/s00417-023-06021-4.
36. Mihalache A, Patil NS, Popovic MM, et al. Tap and inject of intravitreal antibiotics versus pars plana vitrectomy for post-cataract surgery endophthalmitis: a meta-analysis. Can J Ophthalmol. 2024;59(2):73-78. doi: 10.1016/j.jcjo.2023.01.017.
37. Meyer BI, Berry DE, Cribbs BE, et al. Outcomes of Infectious Endophthalmitis in Patients with Systemic Antibiotic Allergies to Penicillins, Cephalosporins, or Vancomycin. Ophthalmol Retina. 2021;5(9):901-909. doi: 10.1016/j.oret.2020.11.015.
38. Halperin SJ, Greenblatt DJ, Prenner JL, et al. Stability of Vancomycin and Ceftazidime With Prolonged Storage at -20°C. Ophthalmic Surg Lasers Imaging Retina. 2023;54(5):281-283. doi: 10.3928/23258160-20230310-01.
39. Sanchez JM, Elinav H, Tiosano L, et al. Endophthalmitis panorama in the Jerusalem area. Int Ophthalmol. 2022;42(5):1523-1535. doi: 10.1007/s10792-021-02142-z.