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CAMBRIDGE OPHTHALMOLOGY SYMPOSIUM

# Postoperative endophthalmitis: optimal management and the role and timing of vitrectomy surgery

JI Maguire

**Abstract**

*Purpose* **To review the evolving role of pars plana vitrectomy, as well as other therapeutic modalities, in the treatment and prevention of postoperative endophthalmitis and its sequelae.**

*Methods* **Medline database searches and review of recent relevant literature on the prevention and treatment of postoperative endophthalmitis.**

*Results* **Despite significant technologic advances in ophthalmic surgery and the ready availability of improved pharmacologic agents, the rates of postoperative endophthalmitis have dramatically increased over the last decade. New surgical procedures, interventions, and techniques have increased patient exposures to this serious surgical complication. Cause, presentation, and outcome vary significantly requiring a tailored approach to each case. Appropriate prophylaxis and good surgical technique remain the mainstays of prevention. Intravitreal antibiotics and pars plana vitrectomy remain the primary treatment options.**

*Conclusions* **Postoperative endophthalmitis is a complex and multifaceted entity with potentially grave visual consequences. It requires a multifaceted approach, including appropriate prevention and prophylaxis, rapid recognition, and aggressive management. Since publication of the Endophthalmitis Vitrectomy Study, improvements in pharmacologic agents and vitrectomy techniques have refocused debate on the role of early surgical intervention in this condition.**

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*Keywords:* endophthalmitis; pars plana vitrectomy; endophthalmitis vitrectomy study (EVS); cystoid macular edema (CME); hypotony; retinal detachment

Wills Eye Institute, Philadelphia, PA, USA

Correspondence: Professor JI Maguire, Wills Eye Institute, 840 Walnut Street, Philadelphia, PA, USA
Tel: +1 215 928 3300; Fax: +1 215 825 2443.
E-mail: jmag629@hotmail.com

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## Introduction

It is clear that the overall rate, as well as number of postoperative endophthalmitis cases, has increased over the past decade. This has been spurred by technical innovation, a significant increase in the number and variety of surgical procedures available, and an increase in resistant organisms in the general community. Postoperative endophthalmitis' variability of onset, presenting signs, and infecting organisms require a flexible approach and optimal management a multi-dimensional strategy.

## Defining terms

Infectious endophthalmitis is an inflammatory reaction involving intraocular tissues and fluids. Common ocular clinical associations include injection, conjunctival chemosis, purulent discharge, corneal oedema, anterior chamber (AC) cell and flare reaction, hypopyon, vitreous opacification, choroidal swelling, periphlebitis, and retinal haemorrhages (Figures 1 and 2). Adnexal swelling may also be present. Symptoms classically include pain and decreased vision.[1–3]

## Classification

Endophthalmitis is typically divided into exogenous, endogenous, or masquerade

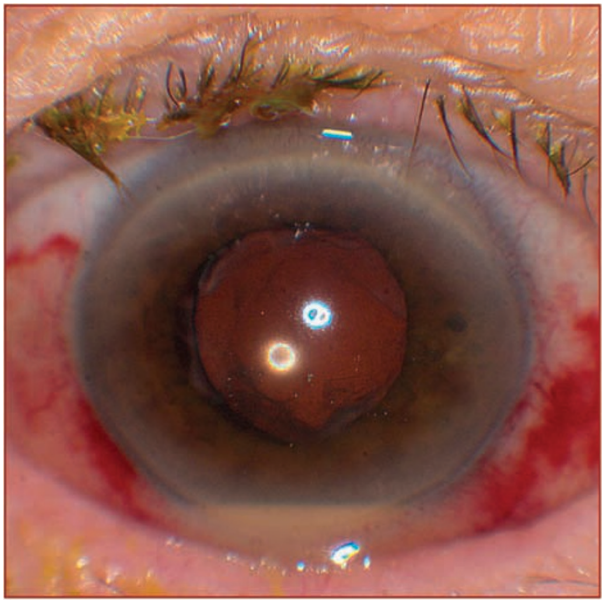

**Figure 1** Hypopyon, conjunctival injection and purulent discharge associated with postoperative endophthalmitis.

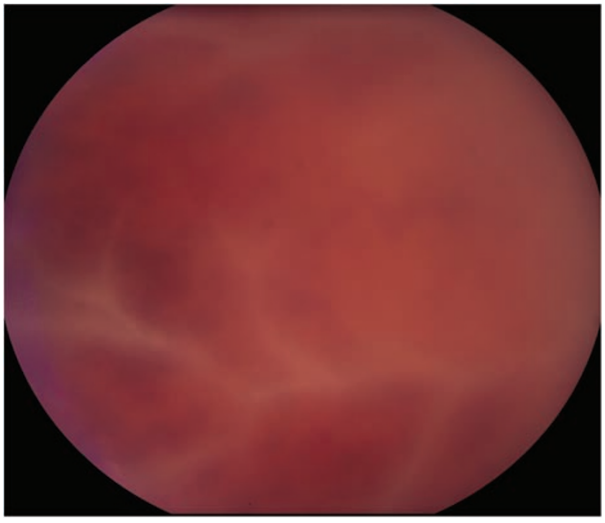

**Figure 2** Periphlebitis and vitritis associated with postoperative endophthalmitis.

syndromes. Exogenous endophthalmitis is classically postoperative (eg, cataract surgery), but may also be post-traumatic and—more rarely—related to organisms with an ability to penetrate intact corneas. Masquerade syndromes mimic clinical findings of endophthalmitis and include hypopyon forming sterile inflammatory disease (eg, Bechet's disease), medications (rifabutin), and neoplasia (eg, large cell lymphoma) (Figures 3 and 4).

It may further be stratified by timing of symptoms and signs including acute, chronic, or subacute onsets. Whatever form it may assume, endophthalmitis is a serious and frequently unforgiving ocular condition

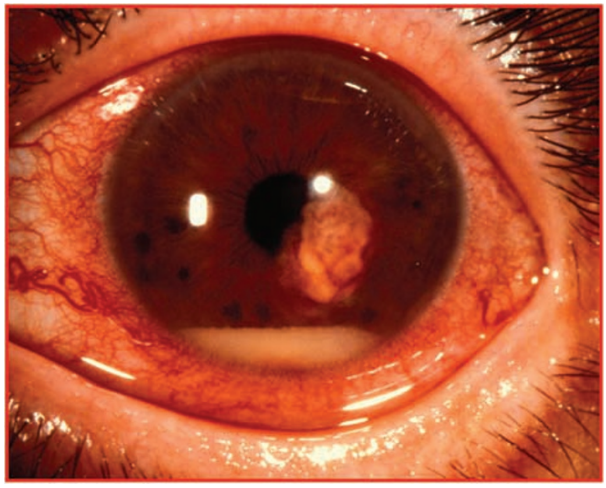

**Figure 3** Masquerade endophthalmitis in eye with metastatic tumor and neoplasia-related hypopyon.

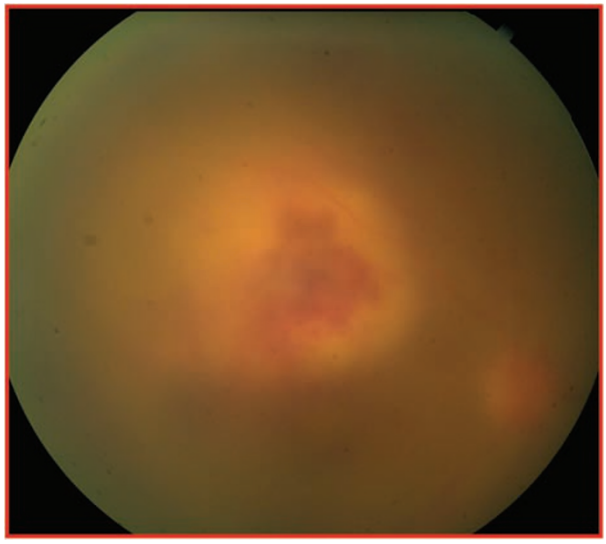

**Figure 4** Vitritis with subretinal abscess and retinal haemorrhage in endogenous endophthalmitis.

prone to severe visual morbidity and even loss of the eye itself. For the ophthalmologist it remains the most significant of surgical complications.

## Incidence

In 1997, Aaberg *et al*[4] published their previous 10-year data on the incidence of postoperative endophthalmitis for all surgical procedures done at Bascom Palmer Eye Institute (BPEI; Table 1). In the 10 years since their report, the number, type, and scope of surgical interventions in all ophthalmic subspecialities have increased dramatically. This, in no small part, has been driven by

**Table 1** Ten-year incidence of endophthalmitis rate per surgical intervention type at Bascom Palmer Eye Institute (1984–1994)

| | | |
|---|---|---|
| Cataract removal with or without IOL | 0.09% | (17/18 530) |
| Pars plana vitrectomy | 0.04% | (2/4583) |
| Penetrating keratoplasty | 0.032% | (4/1233) |
| Glaucoma-filtering | 0.16% | (3/1891) |
| Secondary IOL | 0.53% | (2/379) |
| Combined trab/CE ± IOL | 0.14% | (2/1463) |
| Combined PK with CE ± IOL | 0.00% | (0/304) |
| Keratorefractive surgery | 0.38% | (1/262) |

Abbreviations: CE = cataract extraction; IOL = intraocular lens; PK = penetrating keratoplasty.

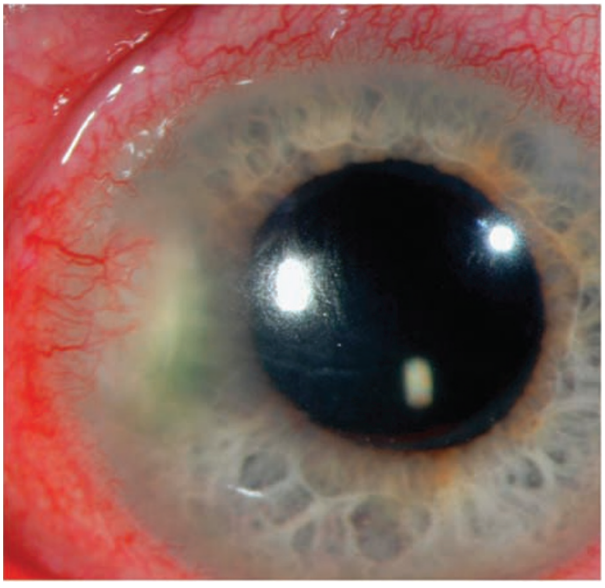

**Figure 5** Methicillin-resistant infected temporal clear corneal cataract wound (courtesy of C Rapauano, MD).

continued technical innovations that make previous procedures—such as cataract removal and lens implantation—more efficient. Postoperative visual rehabilitation is rapid and comfort greater due to smaller wound size and less soft tissue manipulation.[5,6] The expectation is that such improvements, together with better pharmacological agents, would lead to less peri-operative endophthalmitis. This has not been the case. In fact, post-surgical infection has increased for many subspecialties in terms of total numbers and as a per cent of specific surgical procedures. Multiple variables are necessarily involved in peri-operative infection. Innovation does not always equate to increased safety, especially if a learning curve is involved. Many reports in the literature regarding the effectiveness of invasive therapies are geared towards visual results and not necessarily to higher, but still relatively low rates of complication.[7,8]

### *Cataract removal*

The BPEI data noted a 1 : 1090 (0.09%) endophthalmitis incidence in cataract extraction with or without lens implantation between 1984 and 1994.[4] These data were mirrored by Javitt[9] in a review of 53 000 Medicare registered cataract surgeries (endophthalmitis rate 0.08%) reported in 1994. This rate doubled to 0.15% in a 1999 report by Schmitz and colleagues and nearly doubled again by 2006 to rates of .265% in a meta-analysis by Taban *et al* and 0.3% in the European Society of Cataract and Refractive Surgeons (ESCRS) intracameral antibiotic prophylaxis study.[10–12] This dramatic upward surge has been attributed to many factors including the evolution towards clear corneal incisions, temporal placement of incisions, use of topical anaesthesia, and poor wound construction (Figure 5).[5,6,13–15]

### *Glaucoma-filtering procedures/antimetabolites*

The introduction of antimetabolites at the time of glaucoma-filtering procedures markedly increased the long-term success rate of trabeculectomies especially in cases with increased risk of failure. Use of 5 fluorouracil (5-FU) and mitomycin C has steadily evolved into more general use with great success in trabeculectomy. However, its long-term consequences include the evolution of avascular and very thin filtering blebs with increased risk of secondary wound leaks, blebitis, and frank endophthalmitis.[16–18]

Aaberg noted a 0.16% incidence of endophthalmitis in glaucoma-filtering surgeries between 1984 and 1994. Since that time long-term infection rates have increased over 10-fold to 1.7% per year using 5-FU and 2.1–2.6% per year with mitomycin C.[19,20] Bleb-associated endophthalmitis can develop multiple years after surgery and frequently is associated with more virulent Gram-positive pathogens such as *Staphylococcus aureus*, as well as Gram negative bacilli like *Haemophilus*. Visual prognosis is consistently poorer in these eyes compared to immediate postoperative endophthalmitis eyes.[21,22]

### *Cornea and refractive surgery*

In the BPEI study, corneal transplantation, with or without cataract removal and lens implantation enjoyed a low risk of endophthalmitis.[4] In the refractive surgery era the risk of ocular infection is still low. However, the amount of surgical exposures to a young patient population with normal correctable acuity makes the risk of visual loss from postoperative infection even more

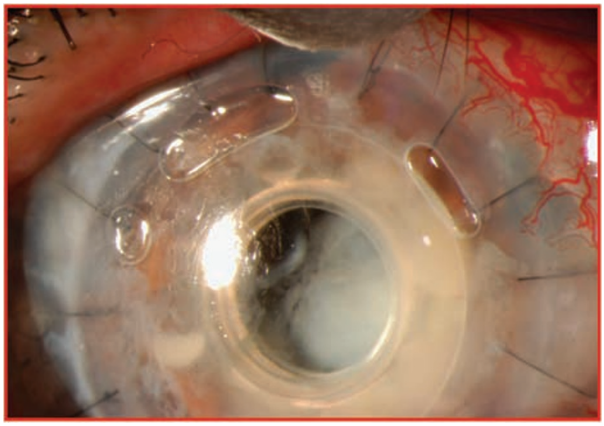

**Figure 6** Endophthalmitis associated with permanent keratoprosthesis (courtesy of B Ayres, MD).

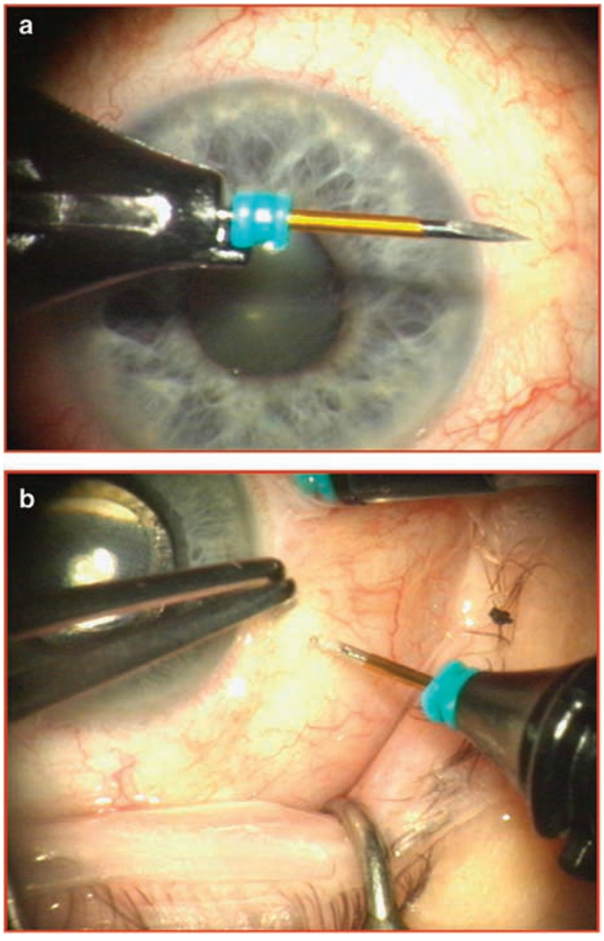


**Figure 7** (a) A 25-gauge trochar loaded on inserting stylette. (b) A 25-gauge trochar at insertion.

concerning. The evolution of refractive techniques from 'blade-based' incisions with radial keratometry to LASEK/LASIK and now Intralase procedures may improve infection risk. Whether substantial risk will be engendered by clear lens refractive implants remains to be seen.

Permanent keratoprosthesis has created great benefit for patients who have failed with other surgical modalities. It requires chronic topical antibacterial coverage. Long-term issues with drug-resistant organisms developing on the ocular surface as well as allergic reactions may increase infection rates over time in these already high-risk eyes (Figure 6).

### *Pars plana vitrectomy*

Endophthalmitis after vitrectomy surgery has been historically low. Incidence data are roughly half that of cataract extraction.[4,23] Surgical incisions (20 or 19 gauge) closed with sutures have been the standard until the recent advent of 25-, 23-, and now even 20-gauge trochar systems that self-seal on withdraw at the conclusion of the surgery. This technique obviates the need for scleral and conjunctival sutures increasing patient's postoperative comfort, cosmesis, and rehabilitation. Recent reports, however, have indicated a possible significant increase in infection rates with newer small gauge trochar systems when compared to traditional sutured incisions (Figures 7a and b). Kunnimoto *et al*[24] at Will Eye Institute noted a nearly sixfold increase in the number of endophthalmitis cases with 25-gauge surgery when compared with 20-gauge sutured approach during the same time period; 0.23% (7 of 3103) *vs* 0.04% (2 of 4583). Vitreous wick formation, retention of greater vitreous gel allowing easier bacterial adhesion, and initial hypotony with wound leaks are postulated as possible causative factors.

### *Intravitreal injections*

Office-based injections of intraocular gas and antibiotics have been a mainstay of ophthalmic therapeutics in retinal detachment and infection. In recent years, the advent of anti-vascular endothelial growth factors and triamcinolone for the treatment of exudative maculopathies has dramatically increased the amount of patient exposures.[25,26] Intravitreal injections are now the third most common billed procedure in the medicare system behind cataract extraction and laser capsulotomy. In combined safety data from the pivotal phase-3 ranibizumab trials (ANCHOR and MARINA) endophthalmitis rates were low, but the sheer number of future intravitreal injections will surely increase the overall number of cases.[27]

Triamcinolone may present further diagnostic dilemmas with pseudoendophthalmitis related to sterile post-injection inflammatory responses or migration of

medication to the AC itself simulating hypopyon formation.[28,29]

## Optimal management of postoperative endophthalmitis

Optimal management of postoperative endophthalmitis depends on the treating physician queried. Most would agree, however, that effective treatment involves prevention, early recognition, and active therapeutics.

### *Prevention*

Prevention of endophthalmitis involves preoperative, operative, and postoperative efforts.[30] Recognition of adnexal risk factors and use of prophylactic antibiotics leading up to cataract removal, and povidone–iodine solution at surgery, have been shown to effectively reduce the amount of ocular surface pathogens.[31–33] Adnexal endophthalmitis risk conditions such as blepharitis, meibomitis, canaliculitis, keratitis sicca, and exposure issues are mandatory elements of every cataract surgery evaluation. Hariprassad *et al*[34] demonstrated that 3 days of moxifloxacin drops every 2–6 h prior to vitrectomy resulted in AC concentrations of medication exceeding the $MIC_{90}$ of most commonly encountered postoperative pathogens.

Reduction of operative risk involves good surgical technique in avoiding intraoperative complications such as capsular tears, vitreous prolapse, and retained lens particles. These events are associated with increased surgical time and associated infection risk. Wound construction in temporal clear corneal incisions is imperative in avoiding endophthalmitis risk. Short, irregular, and planar corneal wounds as well as those with Descemets strips have been shown unstable with ocular pressure differentials during normal blinking. Temporary incision site gaping with generation of negative pressure effects may lead to increased risk of anterior segment contamination.[13,14] Marginal wounds are typically those less than 2 mm depth into the eye. Wounds with demonstrated leaks the day after surgery have a 44-fold increase in risk of endophthalmitis.[15]

Intraoperative use of antibiotics in the infusate has been advocated by some cataract surgeons. However, 10 eyes enrolled in the Endophthalmitis Vitrectomy Study (EVS) had received antibiotics in their infusion solutions.[8] In addition, across-the-board use of antibiotics in this manner increases cost, may increase risk of resistant bacterial species, and in the case of vancomycin, increase risk of cystoid macular oedema (CME). The ESCRS endophthalmitis prophylaxis trial demonstrated a fivefold reduction in endophthalmitis risk when using intracameral cefuroxime compared to peri-operative levofloxacin. Results of the study must be looked at critically due to the high incidence of endophthalmitis in the trial's control group and the lack of postoperative antibiotic drops for 1 day after completion of surgery.[12] Wallin *et al*[15] have demonstrated that starting topical antibiotics the day after surgery—instead of the day of surgery—significantly increased the risk of endophthalmitis ($P = 0.005$; odds ratio 13.7). This theme is echoed by a retrospective report by Moshirfar *et al*[35] describing over 20 000 consecutive uncomplicated cataract procedures. These eyes received pre- and post-surgical fourth-generation topical quinolones with a resultant endophthalmitis rate of 0.06%.

### *Early recognition*

Early recognition of postoperative endophthalmitis leads to early treatment and better visual outcomes.[8] Recognition of post-surgical infections is dependant on many factors. These include proper patient education about operative risks and their manifestations, the surgeon's grasp of endophthalmitis-presenting signs and symptoms, and an awareness of simulating or confounding conditions such as toxic anterior segment syndrome and sterile postoperative inflammation.[1–3,7,30]

### *Treatment*

A definitive approach to treatment of postoperative endophthalmitis is not uniformly agreed upon by many vitreoretinal surgeons. Therapeutics generally involve intravitreal broad-spectrum antibiotics with associated vitreous tap/biopsy (VTB) or PPV. Choice of topical, periocular, and even systemic antibiotics is increasingly controversial compared to 10 years ago.

#### *Endophthalmitis Vitrectomy Study*

Prior to the development and widespread use of vitrectomy techniques starting in the 1980s, standard methods of endophthalmitis treatment involved intravenous, topical, periocular, and intravitreal antibiotic injections. Visual results were frequently poor. As a result PPV gained in popularity. Advocates pointed to the generalized medical axiom that endophthalmitis constituted an abscess and as such needed to be evacuated. Such an approach would reduce microbial load, exo- and endotoxins, inflammatory agents, and vitreous opacities while allowing collection of more extensive samples for analysis and a better distribution of injected antibiotics. Detractors pointed to potential complications of a surgical approach in severely inflamed eyes with poor visibility, a more rapid turnover of intravitreal antibiotics and the risks of delayed therapy

**Table 2** Standard pharmacological agents utilized in the Endophthalmitis Vitrectomy Study

| | |
|---|---|
| *Intravenous Abs* | |
| Ceftazidime | 2 g q 8 h (ciprofloxacin 750 p.o. bid)[a] |
| Amikacin | 6.0 mg/kg c 12 h |
| *Subconjunctival Abs* | |
| Vancomycin | 25 mg in 0.5 cc |
| Ceftazidime | 100 mg in 0.5 cc |
| Dexamethasone | 6.0 mg |
| *Topical Abs* | |
| Vancomycin | 50 mg/ml gtts q h |
| Amikacin | 20 mg/ml gtts q h |
| *Steroids* | |
| Prednisone | 30 mg BID for 5–10 days |

Abbreviations: Abs, antibodies; bid, twice a day.
[a]In penicillin allergic patients.

when awaiting the availability of an operating suite with the needed requisite equipment.

The EVS was a prospective randomized interventional study designed to help answer this debate.[8,36] It asked two questions: (1) is PPV superior to VTB alone in conjunction with broad-spectrum intravitreal antibiotics and (2) do intravenous antibiotics offer additional benefit.

Inclusion criteria included:

(1) clinical signs of postoperative endophthalmitis within 6 weeks of (a) cataract surgery or (b) secondary IOL placement
(2) hypopyon or clouding of aqueous/vitreous obscuring second-order arterioles
(3) corneal clarity suitable for PPV
(4) corneal/AC clarity to allow some iris visualization
(5) visual acuity greater than or equal to light perception (LP) and less than or equal to 20/50

The study enrolled 420 patients. All randomized eyes received intravitreal antibiotics (vancomycin 1.0 mg and amikacin 400 μg) as well as periocular and fortified topical antibiotics (Table 2). A two by two factorial design was utilized with patients being randomized into VTB *vs* PPV groupings and then randomized again into those receiving intravenous antibiotics or not.[8]

Results of the EVS demonstrated that (1) intravenous antibiotics conferred no visual benefit and (2) three-port PPV and VTB were equivalent in eyes with presenting vision better than LP. In eyes with LP acuity, vitrectomy surgery demonstrated significantly better visual results including percentage of eyes with $\geqslant$20/40 vision (33 *vs* 11%), amount of eyes with $>$20/200 vision (56 *vs* 30%), and number of eyes with vision $<$5/200 (20 *vs* 47%).[8]

## Current indications for pars plana vitrectomy

In the dozen years since publication of the EVS results, changes in surgical techniques and technology, pharmacology, and general innovation have naturally lead to re-evaluation of this landmark study's results and its continued relevance to current practice.[37–39] The emergence of vitrectomy is a natural extension of this debate.

Current indications for PPV in cases of endophthalmitis fall into four categories;

(1) EVS protocol-supported vitrectomy
(2) Alternative interpretations of EVS data
(3) Non-EVS protocol endophthalmitis
(4) Complications and sequelae of endophthalmitis

### *EVS-supported vitrectomy*

In addition to eyes presenting with LP vision, the EVS sanctioned PPV in eyes not responding to initial treatment. Secondary procedures were required in 44 of 420 eyes with 90% of these due to increasing inflammation. Eight per cent were in eyes randomized to initial vitrectomy, but fifteen per cent were in the VTB cohort; the latter received vitrectomy.[8,37] Although these numbers were too small for statistical significance, it is instructive to note that eyes in the EVS requiring additional procedures had a much poorer visual prognosis; only 15% achieved a visual acuity greater than 20/40 as opposed to the 'no additional treatment group' where 57% had final acuities of 20/40 or better.[8,37]

The EVS also noted an underpowered trend for better visual prognosis in diabetic eyes that underwent vitrectomy for endophthalmitis.[40–42]

### *Alternative interpretations of EVS data*

Endophthalmitis Vitrectomy Study recommendations for PPV are based on visual acuity; study endpoints involved visual acuity and media clarity. Although post-treatment complications as well as secondary procedures were recorded, final recommendations were not based on these related events.[8] In addition, initial enrolment to the EVS was, in part, dependant on corneal and anterior segment clarity. Theoretically, eyes with more significant or advanced disease, or with more virulent pathogens, may have been recused from enrollment in the EVS. An argument might be made that such eyes may have done better with more aggressive management employing PPV.[43,44,39,45]

Kuhn and Gini have advocated an approach not based on presenting acuity alone, but on the overall clinical picture and course. Their treatment includes intravitreal injections of antibiotics and steroid (ceftazidime,

vancomycin, and dexamethasone) with topical and oral antibiotics in eyes with visualization of some retinal detail or a good red reflex.[38,45] If there is a poor reflex, absent retinal detail at presentation, or no improvement within 24 h of initial conservative therapy with intravitreal injections, PPV is offered to the patient. Their vitrectomy technique differs significantly from that of the EVS. In the EVS, vitrectomy was defined as removal of at least 50% of the vitreous, but it was recommended that no purposeful removal of the posterior hyaloids be undertaken due to fear of secondary complication.[8]

Kuhn and Gini define a 'complete' PPV as that starting at the anterior segment and working posterior. This includes scraping the cornea, utilizing temporary keratoprosthesis where necessary, evacuating the AC of fibrin and cellular material, and then working purposely posterior towards the retina. Engagement and removal of the posterior hyaloids with irrigation of any macular hypopyon and debris is emphasized. Conservative shaving of the vitreous base is recommended depending on limitations in visualization.[38,45] Silicone oil is an option in necrotic or detached retina or those otherwise having multiple tears.[38,45] In their non-randomized consecutive series of 47 patients, 91% achieved a visual acuity of 20/40 or better compared to 53% in the EVS ($P<0.0001$). In this limited report, no retinal detachments developed (8.3% EVS), there were no lost eyes from phthisis (6% EVS), and no additional PPV was required.[8,38,45–47] The authors point out that this approach is aided by advances in vitrector technology and the development of wide-angle viewing systems since the EVS. The development of the endoscope in vitrectomy surgery has likewise increased the amount of patients, previously excluded by the EVS inclusion criteria, to more aggressive management.[48]

Advent of third- and fourth-generation quinolone antibiotics has likewise re-focused attention on the utility of adjuvant systemic antibiotics; the excellent intravitreal penetration of these antibiotics with oral administration has necessarily eliminated the argument of other previously administered poorly penetrating antibiotics while obviating the need for expensive hospital admissions.[49–51]

### *Non- EVS protocol endophthalmitis*

The EVS enrolled eyes with endophthalmitis who had undergone primary cataract extraction with lens implantation, or secondary lens implantation cases, within 6 weeks of documented infection. Currently, non-cataract-associated postoperative endophthalmitis from indolent infection, bleb-associated infection, post-intravitreal injection—as well as non-postoperative infections from post-traumatic and endogenous endophthalmitis cases—fall outside the sphere of the EVS protocol. These cases comprise a heterogeneous group of eyes with disparate presentations and outcomes.

Indolent infections are classically delayed several weeks or months after cataract removal. Common organisms include *Staphylococcus epidermidis*, *Propionibacterium* and *Candida parapsolosis*. They often present with sterile inflammatory-type symptoms that are initially responsive to topical steroids alone. These pathogens are frequently slow growing and sequestered in the capsular bag. As a result response to intravitreal injections alone is often poor or short lived. Pars plana vitrectomy with a generous capsulotomy or explantation of the IOL and capsular bag itself is often required for an effective resolution.[52] The effectiveness of orally administered fourth-generation quinolones, such as gatifloxacin and moxifloxacin, may obviate the need for such aggressive procedures in the future. Bleb-associated endophthalmitis may benefit from PPV secondary to generally more virulent-associated bacteria.[50,51]

### *Post-treatment complications of endophthalmitis*

Eyes with endophthalmitis are at increased risk for multiple additional complicating conditions resulting from the associated sequelae of a panuveitic response. These include premacular gliosis with secondary surface wrinkling, CME, retinal detachment, non-clearing vitreous opacification, and most ominously, hypotony.

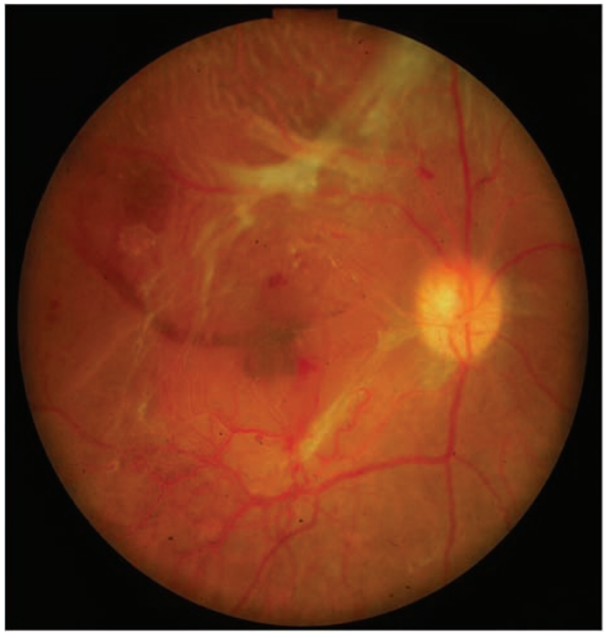

**Figure 8** Premacular gliosis with tractional elevation of retina.

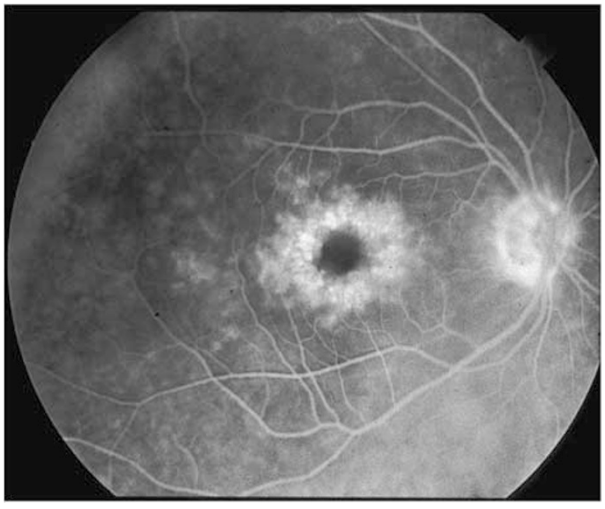

**Figure 9** Fluorescein angiogram of chronic cystoid acular oedema (CME).

Although some of these problems may resolve on their own others can lead to fixed or progressive severe visual and ocular morbidity; surgical intervention with PPV may lead to visual improvement or ocular survival.

*Premacular gliosis*

Epiretinal membranes are typically idiopathic. They are also associated with several defined conditions including inflammatory disease. Pluripotential cells such as hyalocytes, Mueller cells, retinal pigment epithelium, and glial cells may readily migrate to the retinal surface.[53] In endophthalmitis, the above cell types may be activated by the influx of various inflammatory cells and their mediators. In this milieu, cellular production of collagen and extracellular matrix may create proliferation and then contraction of surface membranes leading to surface wrinkling (Figure 8).

*Cystoid macular oedema*

The inflammatory cascade involves the production of multiple cytokines and other related growth factors that play an active role in vascular permeability. Resultant hypotony, choroidal thickening, epiretinal membrane formation, anterior segment abnormalities, such as posterior synechiae and IOL capture, and vitreous debris with associated inflammatory stimuli may cause the development and persistence of CME even after resolution of the initial severe inflammatory reaction from active infection. Although aggressive management with topical, periocular, intravitreal, and systemic steroidal agents may be helpful, restoration of normal anatomy with surgery may be necessary.

Vitrectomy surgery has the ability to peel premacular membranes and internal limiting membranes, remove vitreomacular traction, and remove vitreal adhesions to the iris, capsular bag, and IOL as well as cyclitic membranes; all play a role in the development and persistence of chronic CME (Figure 9).

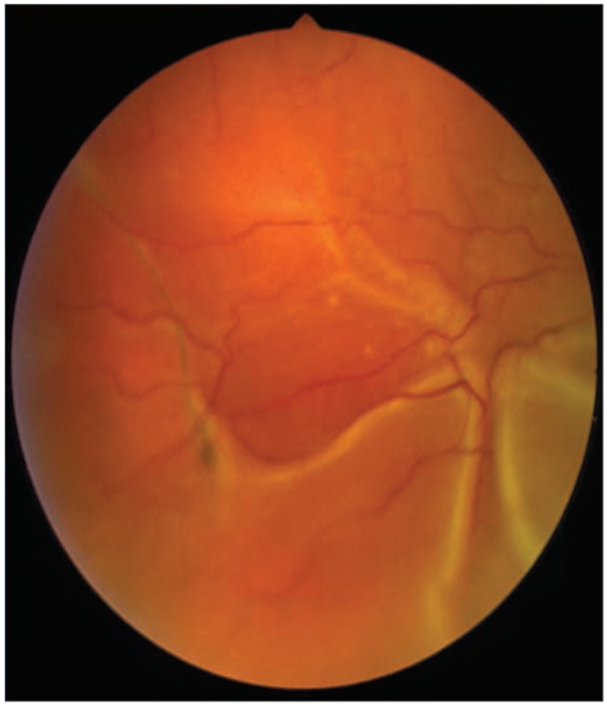

**Figure 10** Rhegmatogenous retinal detachment with early proliferative vitreoretinopathy.

*Retinal detachment*

Rhegmatogenous retinal detachment (RRD) risk is greater in association with endophthalmitis.[37,46,47] Cataract extractions with broken capsules, longer operative times, and retained lens material generally have a greater risk of resultant intraocular infection.[54] Not surprisingly, these events also increase risk of RRD.

The incidence of retinal detachment in the EVS was 8.3% and independent of treatment approach with PPV or VTB.[8,37,46] Frequency of RRD was higher in patients requiring additional procedures after initial randomization, more virulent organisms, and a poorer presenting visual acuity. Visual prognosis was significantly worse in RRD eyes with only 27% achieving acuities better than 20/40; non-RRD eyes fared twice as well with final visions of 20/40 or better in 55% of patients. Surgical intervention utilizing combined vitreoretinal techniques resulted in anatomic success 78% of the cases with 38% having vision equal or greater than 20/40.[37,46] Poorer results may be due to multiple tears, necrotic retina, proliferative vitreoretinopathy, and optic neuropathy (Figure 10).

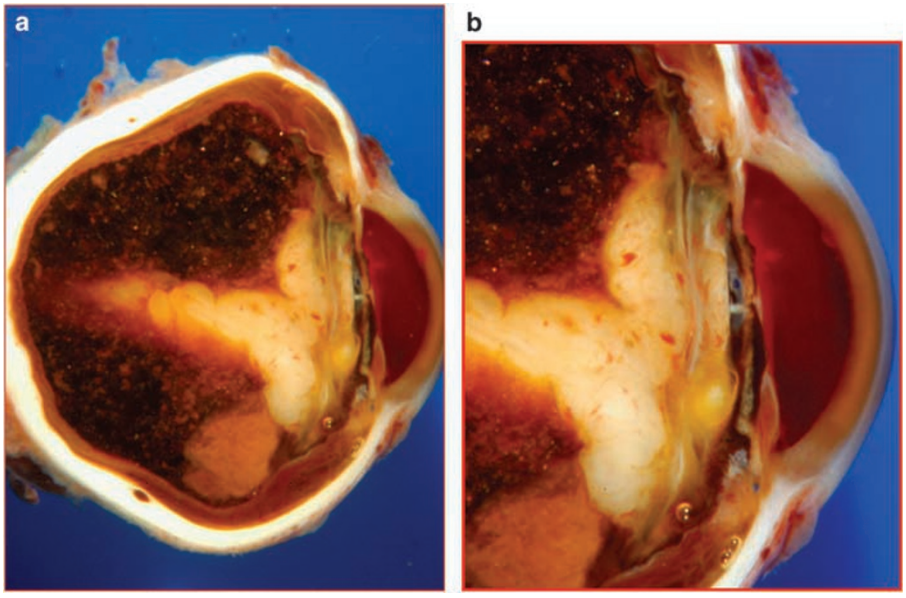


**Figure 11** (a) Whole globe section with choroidal detachments, funnel retinal detachment, and cyclitic membranes (courtesy of R Eagle, MD). (b) Cyclitic membrane, retinal detachment in pseudophakic eye (courtesy of R Eagle, MD).

*Non-clearing vitreous opacities*

Effective eradication of bacteria with intravitreal injections still leaves some element of vitreous opacification made up of inflammatory cells, transudates, and necrotic tissues. Aggressive management with topical and even oral steroids to eliminate any residual inflammatory response often leads to gradual and total resolution of vitreous opacities. Vitrectomy is effective in removing non-clearing debris or to effect more rapid visual rehabilitation.

*Hypotony*

Significant and protracted reduction of intraocular pressure (IOP) after treatment of endophthalmitis is an ominous sign. The differential diagnosis involves active wound leaks, choroidal detachment, retinal detachment, destruction of ciliary body function, and ciliary body detachment from choroidal effusion or cyclitic membranes. Long-term hypotony devolves into phthisis[55] (Figures 11a and b).

With the exception of wound leaks, proper timing of intervention with use of vitreoretinal techniques may salvage vision and the globe itself. Drainage of large choroidal detachments and small effusions may restore proper ciliary body apposition with a normal return of IOP. Repair of retinal detachment, with or without use of silicone oil, and excision of anterior vitreoretinal membranes, anterior loop traction, and cyclitic membranes can serve to elevate IOP to a functional range.

## Summary

The limitations of the EVS today result from multiple new surgical techniques susceptible to postoperative infection—but not included in the EVS protocol, alternate interpretation of its results based on potential complications rather than vision differences, the evolution of new surgical techniques and viewing apparatus, and the development of new pharmacological agents with improved ocular penetration.

In addition, the EVS left many other management questions unanswered including use of intraocular steroids.

Results of the EVS, however, still serve as a primer and able platform from which vitreoretinal surgeons may base current management of postoperative endophthalmitis. Like all medical conditions, the number of presenting historical and clinical variables is large. Even well-performed randomized prospective studies have their limits as well as 'shelf life' due to the normal pace of medical innovation and discovery.[56] As physicians and surgeons, we are a product of training and experience. Introduction of bias into the treatment equation is a normal consequence of complicated and multi-factorial disease states. This does not necessarily make one approach correct or not, only different.

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