

Nosocomial Acute-Onset Postoperative Endophthalmitis at a University Teaching Hospital (2002–2009)

CHARLES C. WYKOFF, M. BRANDON PARROTT, HARRY W. FLYNN, JR, WEI SHI, DARLENE MILLER, AND EDUARDO C. ALFONSO

- **PURPOSE:** To evaluate acute-onset postoperative endophthalmitis occurring at an academic medical center and to compare rates over the last 25 years at a single institution.
- **DESIGN:** Retrospective, consecutive case series.
- **METHODS:** Medical records were reviewed for all patients diagnosed with acute-onset postoperative nosocomial endophthalmitis from 2002 through 2009 associated with surgery at Bascom Palmer Eye Institute.
- **RESULTS:** The 8-year frequency of acute-onset postoperative endophthalmitis was 0.025% (14 of 56 672 intraocular surgeries). The rate was 0.028% (8/28 568) for cataract surgery and 0.011% (2/18 492) for pars plana vitrectomy (PPV). Both PPV endophthalmitis cases followed 20-gauge surgery and no cases followed small-gauge, transconjunctival PPV (n = 2262). Three cases occurred following penetrating keratoplasty (3/2788, 0.108%). The most common bacterial isolate was *Staphylococcus* (n = 7, 50%). Initial treatment involved ocular paracentesis (n = 8, 57%) or vitrectomy (n = 5, 36%), in combination with injection of intraocular antibiotics (n = 14, 100%). Vancomycin and ceftazidime were used in 13 eyes (93%) and intraocular steroids were given initially to 9 eyes (64%). Final visual acuity was $\geq 20/200$ in 9 eyes (64%) and 2 eyes (14%) were no light perception. At this institution since 1984, there has been a statistically significant trend for a decreasing rate of acute-onset postoperative endophthalmitis (1984–1994: 0.09%; 1995–2001: 0.05%; 2002–2009: 0.025%; $P < .001$).
- **CONCLUSION:** At a university teaching hospital involving resident, fellow, and faculty surgeons, the frequency of acute-onset postoperative nosocomial endophthalmitis is low, has not increased in the era of sutureless clear corneal cataract surgery, and has steadily decreased when compared to prior time periods from the same institution. (Am J Ophthalmol 2010;150:392–398. © 2010 by Elsevier Inc. All rights reserved.)

ENDOPHTHALMITIS IS A SERIOUS, SIGHT-THREATENING condition that is classified into 2 broad categories: endogenous or exogenous. Exogenous cases include those occurring postsurgically, those related to antecedent trauma, and those attributable to extension of an extraocular infection into the eye. The reported rate of acute-onset postoperative endophthalmitis varies by surgical procedure; because of a variety of factors including improved surgical technique, routine povidone-iodine use, and appropriate use of improved antibiotics, the rate seems to have declined dramatically over the past century.^{1–5}

More recently, with evolving trends in cataract and vitrectomy surgery toward smaller incisions and sutureless techniques, concern has arisen from some studies about an increased risk of postoperative endophthalmitis.^{6–12}

The purpose of the current study was to determine the frequency of acute-onset postoperative endophthalmitis over the most recent 8-year period, 2002 through 2009, and to compare these data with previous data from the last 25 years from the same institution.

PATIENTS AND METHODS

THE STUDY DESIGN WAS A RETROSPECTIVE, CONSECUTIVE case series. The medical and microbiological records of all patients who underwent surgery at Bascom Palmer Eye Institute and were diagnosed within 6 weeks of their surgery with postoperative endophthalmitis between January 1, 2002 and December 31, 2009 were reviewed.

The Quality Assurance Committee of our hospital requires that all cases of postoperative endophthalmitis be reported for infection control. Using the constraints of postoperative endophthalmitis occurring within 6 weeks of the surgical procedure, it is unlikely that this study missed patients who developed endophthalmitis and moved or sought care by another institution. However, if such an instance did occur, the rates reported herein would be underreported.

As part of operating room protocol in effect since 2000 at Bascom Palmer Eye Institute, 5% povidone-iodine solution was used to prepare the lids, lashes, and conjunctiva before all surgical procedures.^{13,14} In addition, 10% povidone-iodine solution was used to prepare the skin of the lids and face in the periorbital area before all surgical procedures. Some of the cataract cases in this report have

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From the Department of Ophthalmology, Bascom Palmer Eye Institute, University of Miami School of Medicine, Miami, Florida.

Inquiries to Charles C. Wykoff, Bascom Palmer Eye Institute, 900 NW 17th Street, Miami, FL 33136; e-mail: cwykoff@med.miami.edu

TABLE 1. Demographics, Clinical Features, and Culture Data for Patients With Acute-Onset Postoperative Endophthalmitis (2002–2009)

Patient (Eye, Age ^a)	Year	Surgery	Intraoperative Complications	Days to Diagnosis	Aqueous Culture	Vitreous Culture	Organism Cultured
1 (OD,68)	2003	Phaco/PCIOL	Vitreous loss, RLF	22	NP	+	Staph epi
2 (OD,51)	2003	Phaco/PCIOL	None	30	NP	+	Staph epi
3 (OD,52)	2003	Phaco/PCIOL	Iris prolapse	4	–	+	Staph aureus
4 (OD,82)	2004	Phaco/PCIOL	None	2	NP	+	Strep pneumo
5 (OD,84)	2005	Phaco/PCIOL	None	15	NP	+	Staph epi
6 (OD,69)	2006	Phaco/PCIOL	None	8	NP	+	Staph epi
7 (OD,71)	2006	20-g PPV/SB/EL/SO	None	6	NP	–	None
8 (OS,49)	2007	20-g PPV/PPL/MP/SB/SO	None	6	–	NP	None
9 (OS,19)	2007	Phaco/PCIOL	None	1	NP	–	None
10 (OS,58)	2008	PK & sutured iridoplasty	None	23	+	NP	Strep mitis
11 (OD,61)	2008	PK & ECCE/ACIOL	Vitreous loss	5	NP	+	Staph epi
12 (OD,63)	2009	Removal of PCIOL and insertion of ACIOL	None	25	NP	NP	NP
13 (OD,70)	2009	PK	None	2	+	+	Strep agal
14 (OD,55)	2009	Phaco/PCIOL	None	10	NP	+	Staph epi

– = negative; + = positive; ACIOL = anterior chamber intraocular lens; ECCE = extracapsular cataract extraction; EL = endolaser; g = gauge; MP = membrane peel; NP = not performed; OD = right eye; OS = left eye; PCIOL = posterior chamber intraocular lens; Phaco = phacoemulsification; PK = penetrating keratoplasty; PPL = pars plana lensectomy; PPV = pars plana vitrectomy; RLF = retained lens fragment; SB = scleral buckle; SO = silicone oil; Staph aureus = *Staphylococcus aureus*; Staph epi = *Staphylococcus epidermidis*; Strep agal = *Streptococcus agalactiae*; Strep mitis = *Streptococcus mitis*; Strep pneumo = *Streptococcus pneumoniae*.

^aAge is in years at time of endophthalmitis diagnosis.

been reported previously.^{15,16} Comparison of the current data with endophthalmitis rates since 1984 was performed using data from 2 previously published manuscripts from the same institution.^{4,5}

Data collected included patient age, gender, date and type of initial surgical intervention, other patient medical conditions, date of endophthalmitis diagnosis, associated exam findings and patient symptoms, date and details of initial and subsequent treatment strategies, microbiological culture results, and follow-up visions and dates. Microbiological analysis was performed as previously reported.⁴ Culture and organism identification techniques did not change during the study period.

All statistical analysis was performed using SPSS 17.0 for Windows (SPSS Inc, Chicago, Illinois, USA). Analysis of variance and Student *t* test were used for visual acuity comparisons among organisms and corticosteroid usage respectively. The Cochran-Armitage trend test was used to analyze frequency trends.

RESULTS

A TOTAL OF 56 672 INTRAOCULAR SURGERIES WERE PERFORMED at Bascom Palmer Eye Institute over the 8-year study period through 2009. During this time, acute-onset postoperative nosocomial endophthalmitis was diagnosed in 14 eyes of 14 different patients (Table 1), yielding a frequency of 0.025%. The patients' mean age was 60.9

years (median 62, range 19–84). There were 7 male patients (50%) and 11 right eyes (79%). Six patients (43%) identified themselves as white, 7 (50%) as Hispanic, and 1 (7%) as black. Diabetes mellitus affected 4 patients (29%) (Patients 1, 3, 6, and 11); 1 patient (7%) (Patient 2) was using methotrexate and etanercept for management of rheumatoid arthritis, and 1 patient (7%) (Patient 14) was on hemodialysis because of amyloidosis.

Cataract surgery accounted for the majority of cases of endophthalmitis (8 cases out of 28 568 cataract surgeries, 0.028%), of which 2 had documented intraoperative complications: 1 posterior capsular rent with vitreous loss requiring an anterior vitrectomy and another case with significant intraoperative iris prolapse. The 2 cases of endophthalmitis associated with pars plana vitrectomy (PPV) occurred following 20-gauge vitrectomies in 2006 and 2007 (2/18 492, 0.011%). No cases of endophthalmitis occurred following the 2262 transconjunctival vitrectomies performed (23- or 25-gauge) during the study time period. Three cases of endophthalmitis occurred following penetrating keratoplasty (3/2788, 0.108%), 1 with concurrent cataract surgery complicated by vitreous loss requiring an anterior vitrectomy and 1 with concurrent iridoplasty. Two of the 3 cases of endophthalmitis following penetrating keratoplasty were associated with contaminated donor corneal tissue. In both cases, the same bacterial isolate was recovered from the donor corneal rim and the ocular paracentesis performed when the patients presented with endophthalmitis. One case of endophthalmitis occurred

TABLE 2. Perioperative Medications Used Before Presentation With Endophthalmitis

Patient	Preoperative	Intraoperative	Postoperative
1	FQ	Subconj: C, D	FQ
2	None	Top: FQ	FQ
3	FQ	Top: FQ, PF	FQ
4	None	Top: Poly, PF	Poly, PF
5	None	Top: FQ, PF	FQ, PF
6	None	Top: G, PF. Subconj: G, D. IV: T	V, G
7	None	Top: FQ, PF. Subconj: G, D	FQ, PF
8	None	Top: FQ, PF. Subconj: G, D	FQ, PF
9	FQ	G in irrigation	FQ, PF
10	None	Top: FQ, TO, D. Subconj: C, D	FQ, PF, NSAID
11	Poly	Top: N, P, D. Peribulbar: T	Poly, PF
12	None	Top: FQ, PF. Subconj: C, D	FQ, PF
13	None	Subconj: G, T	Poly, PF
14	None	Top: FQ, PF	FQ, PF, NSAID

C = cefazolin; D = dexamethasone; FQ = fluoroquinolone; G = gentamicin; IV = intravitreal; N = neomycin; NSAID = nonsteroidal anti-inflammatory drug; P = polymyxin B; PF = prednisolone acetate 1%; Poly = polytrim; Subconj = subconjunctival; T = triamcinolone; TO = tobramycin; Top = topical; V = vancomycin.

following secondary intraocular lens (IOL) implantation (1/1783, 0.056%); an anterior chamber IOL was inserted with removal of a dislocated posterior chamber IOL assisted by 23-gauge vitrectomy in a previously vitrectomized eye (Patient 12). No cases occurred following glaucoma surgery (n = 5041).

In the perioperative period of the surgery that eventually resulted in endophthalmitis, treating physicians used antibiotics and corticosteroids as they believed appropriate (Table 2). Preoperatively, 4 patients used topical antibiotic eye drops, including a fluoroquinolone (n = 3) or polytrim (n = 1). Intraoperatively, all patients were given antibiotics by various routes: 11 were given topical drops including a fluoroquinolone (n = 8), polytrim (n = 1), gentamicin (n = 1), tobramycin (n = 1), or neomycin and polymyxin B (n = 1); 7 were given subconjunctival injection of cefazolin (n = 3) or gentamicin (n = 4); 1 was given gentamicin (8 µg/mL) in the irrigation fluid during cataract surgery. Additionally, 12 patients were given intraoperative steroids including topical prednisolone acetate (n = 8), topical dexamethasone (n = 2), subconjunctival dexamethasone (n = 6), subconjunctival triamcinolone (n = 1), peribulbar triamcinolone (n = 1), or intravitreal triamcinolone (n = 1). Postoperatively, all patients were given topical antibiotic eye drops, including

TABLE 3. Visual Acuity, Treatment, and Outcomes for Patients With Acute-Onset Postoperative Endophthalmitis (2002–2009)

Patient	Visual Acuity at Diagnosis	Management (Intravitreal Medications)	Visual Acuity at Follow-up (Months)
1	HM	PPV/PPL (V, C, D)	20/30 (12)
2	CF	PPV (V, C, D)	20/20 (20)
3	CF	T/I (V, C, D)	20/20 (26)
4	LP	PPV (V, C, D), repeat PPV (V, C, D) 13 d later	NLP
5	CF	T/I (V, C, D)	20/20 (36)
6	CF	T/I (V, C, D)	20/30 (6)
7	HM	T/I (V, C, D)	HM (12)
8	LP	T/I (V, C)	NLP
9	20/100	T/I (V, C)	20/25 (12)
10	HM	T/I (V, C)	20/200 (6)
11	LP	T/I (V, C), repeat I (V, D) 4 d later	20/200 (3)
12	HM	I (V, C)	HM (12)
13	LP	PPV/I (V, D), then T/I (V, D) 5 d later	LP (1)
14	20/200	PPV/I (V, C, D)	20/25 (1)

C = ceftazidime; CF = counting fingers; d = days; D = dexamethasone; HM = hand motions; I = injection of intraocular antibiotics; LP = light perception; NLP = no light perception; PPL = pars plana lensectomy; PPV = pars plana vitrectomy; T/I = ocular paracentesis and injection of intraocular antibiotics; V = vancomycin.

a fluoroquinolone (n = 10), polytrim (n = 3), or vancomycin and gentamicin (n = 1); additionally, 10 patients were given prednisolone acetate eye drops and 2 patients were given a topical nonsteroidal anti-inflammatory eye drop.

• **CLINICAL PRESENTATION, MANAGEMENT, MICROBIOLOGY, AND OUTCOMES:** At initial evaluation, 11 of the 14 patients (79%) noted increased redness, 12 (86%) noted decreased vision, and 10 (71%) complained of significant pain. Clinical examination revealed a hypopyon in 9 of the 14 eyes (64%), and 4 eyes (29%) had fibrin in the anterior chamber without a hypopyon. Presenting vision was 20/200 or better in 2 patients (14%), counting fingers to hand motions in 8 patients (57%), and light perception in 4 patients (29%) (Table 3). The mean time from surgery to diagnosis with endophthalmitis was 11.4 days (SD 9.8 days, median 7 days, range 1-30 days), with 7 patients (50%) presenting within 1 week of surgery.

As initial treatment, 8 patients (57%) underwent ocular paracentesis and intraocular injection of antibiotics, 5 patients (36%) underwent vitrectomy with intraocular injection of antibiotics, and 1 (7%) underwent intravitreal injection of antibiotics without ocular paracentesis because of hypotony (Table 3). Intravitreal vancomycin and ceftazidime

TABLE 4. Frequency of Acute-Onset Postoperative Endophthalmitis: Trends Over 25 Years

Surgical Procedure	Frequency of Postoperative Endophthalmitis (%) ^a			P for Trend ^c
	1984–1994 ^b	1995–2001 ^b	2002–2009	
Cataract	34/41 654 (0.08)	8/21 972 (0.04)	8/28 568 (0.03)	.002
Pars plana vitrectomy	3/6557 (0.05)	2/7429 (0.03)	2/18 492 (0.01)	.09
Glaucoma	4/3233 (0.12)	4/1970 (0.20)	0/5041 (0)	.03
Penetrating keratoplasty	5/2805 (0.18)	2/2362 (0.08)	3/2788 (0.11)	.46
Secondary intraocular lens	5/1367 (0.37)	1/485 (0.21)	1/1783 (0.06)	.05
Total	54/58 123 (0.09)	17/35 916 (0.05)	14/56 672 (0.03)	<.001

^aFrequency data presented as a percentage of all cases performed.

^bData from 1984–1994 and 1995–2001 from published manuscripts from the same institution.^{4,5}

^cCochran-Armitage trend test.

zidime were given to 13 eyes (93%). Intraocular steroid (dexamethasone) was injected into 9 eyes (64%) as part of initial treatment at the discretion of the treating physician. A second intervention was performed in 3 patients: 1 underwent a second PPV (Patient 4) and 2 underwent a second intravitreal injection of vancomycin and dexamethasone (Patients 11 and 13).

Staphylococcus was isolated from 7 eyes (50%), including 6 cases (43%) of *Staphylococcus epidermidis* and 1 case (7%) of *Staphylococcus aureus*. Intraocular cultures were negative in 3 cases (21%). Other organisms isolated were *Streptococcus pneumoniae* (n = 1), *Streptococcus mitis* (n = 1), and *Streptococcus agalactiae* (Table 1).

Patients were followed for a mean of 12 months (range 1–36 months; Table 3). Final vision $\geq 20/200$ was achieved in 9 of the 14 eyes (64%), and 7 (50%) achieved $\geq 20/40$. Two eyes (14%) were ultimately hand motions, 1 (7%) was light perception, and 2 (14%) were no light perception.

• **COMPARISON WITH PRIOR ENDOPHTHALMITIS DATA FROM THE SAME INSTITUTION:** Endophthalmitis rates from 1984 to 1994⁴ and from 1995 to 2001⁵ are compared with the current data (2002–2009) in Table 4. There is a statistically significant trend for a decreasing rate of endophthalmitis following all types of intraocular surgery, from 0.09% (1984–1994) to 0.05% (1995–2001) to 0.025% (2002–2009) ($P < .001$). The rate of endophthalmitis following cataract surgery follows a similarly decreasing trend, from 0.08% (1984–1994) to 0.04% (1995–2001) to 0.028% (2002–2009) ($P = .002$). No surgical category demonstrates an increasing trend over these time periods.

Including all cases of endophthalmitis from 1995 to 2009, the time from surgery to diagnosis with endophthalmitis was significantly shorter for eyes that were culture-negative (mean 4.3 days, SD 2.4 days, median 5 days, range 1–7 days) compared to those that were culture-positive (mean 12.3 days, SD 11.8 days, median 8.5 days, range 1–42 days) ($P = .003$, t test). Additionally, 13 of 31 eyes (42%) have undergone both aqueous and vitreous sampling as part of their initial management; of these, 5

(38%) had positive intraocular cultures from both locations, 4 (31%) had positive cultures from vitreous with negative aqueous samples, 3 (23%) had positive cultures from aqueous with negative vitreous samples, and 1 (8%) had negative cultures from vitreous and aqueous samples.

DISCUSSION

NOSOCOMIAL INFECTIONS AFFLICT AN ENORMOUS NUMBER of people, at a huge monetary cost and an immeasurable personal burden.¹⁷ In 2002 it is estimated that 4.5 of every 100 patients admitted to a United States hospital contracted a nosocomial infection.¹⁸ Postoperative surgical site infections account for a significant proportion of these infections, occurring in an estimated 500 000 patients each year, among an estimated 27 million surgical procedures.¹⁹ Fortunately, cataract surgery benefits from a relatively low rate of postoperative infection. Cataract surgery is 1 of the most common surgeries in the United States, with an estimated 2 to 3 million cases performed each year with a projected future increase, given the demographics of our aging population. Therefore, even a small increase in the rate of postoperative endophthalmitis^{6,7,9} could have significant effects on a population basis. In the current series, cataract surgery accounted for the majority of cases of endophthalmitis (8 of 14 cases) and showed a significant decrease in the rate of postoperative infections over the last 25 years.

Our rate of acute-onset postoperative endophthalmitis of 0.025% (0.25 per 1000) after all intraocular surgeries and 0.028% (0.28 per 1000) after cataract surgery are on the lower end of estimates from other large series. Hatch and associates recently reported an endophthalmitis rate of 1.4 per 1000 in a series of more than 400 000 cataract surgeries from Canada²⁰ and observed this to be similar to other large series from many developed countries, ranging from 0.48 to 2.15 cases per 1000 cataract surgeries.^{6,7,21–23} Additionally a recent large, prospective, multicenter trial in Europe reported the rate of endophthalmitis to be 1.79

per 1000 cataract surgeries (29 of 16 211 cases) for all patients and to significantly decrease from 2.96 to 0.62 per 1000 cases with the addition of intracameral cefuroxime.²⁴ Possible variables contributing to these differences in the reported rates of endophthalmitis include differences in study methodology, definitions of endophthalmitis, surgical technique, patient populations, environmental influences, and surgeon volume.^{24,25}

In the current study, individual treating physicians had the flexibility to use preoperative and postoperative antibiotics as they saw fit and no prospective antibiotic protocol was used. However, use of topical povidone-iodine before intraocular surgery was mandated by the Infection Control Committee and the Hospital Bylaws. Antibiotics were used in the irrigation fluid (gentamicin) during cataract surgery by only 1 surgeon over the course of the study; all other cases were performed without intracameral antibiotics. Cefuroxime was not used in the irrigating fluid or as an intracameral injection in any patient in the current series.

PPV had the lowest rate of associated endophthalmitis in the current series (2/18 492; 0.011%). Transconjunctival, sutureless vitrectomy techniques have been readily incorporated into many surgical practices since their introduction in 2002²⁶ because of their benefits, including increased patient comfort, faster visual recovery, decreased operative times, decreased corneal astigmatism, and less conjunctival scarring.^{27,28} However, enthusiasm for these vitrectomy systems has been tempered by a more limited assortment of ancillary instruments and reports of increased hypotony²⁹⁻³² and endophthalmitis.¹⁰⁻¹² Recommendations to optimize wound architecture in order to minimize postoperative wound leakage have reported beveled sclerotomies superior to sclerotomies that are perpendicular to the sclera³³⁻³⁵; meticulous wound construction by conjunctival displacement before making a beveled sclerotomy, postoperative examination and removal of vitreous wicks, and confirmation of a water-tight wound following cannula removal with utilization of suture closure when needed likely minimize the risk of postoperative endophthalmitis.³⁶⁻³⁸ In the current series, while the total number of transconjunctival PPV performed is relatively small (2262), there were no cases of postoperative endophthalmitis.

Bacterial and fungal endophthalmitis following penetrating keratoplasty is unusual, but the frequency is likely higher than the rate of endophthalmitis following cataract surgery or PPV.³⁹⁻⁴¹ In the current series, the frequency was 0.108% (3/2788), with 2 cases representing combined surgeries, 1 with concurrent cataract surgery and 1 with concurrent iridoplasty. A recent meta-analysis of donor corneoscleral rim cultures reported a 14% positive culture

rate with a 0.2% rate of associated endophthalmitis; endophthalmitis occurred 12 times more often in the setting of a culture-positive donor cornea.³⁹ Such contaminated donor tissue, identified as the likely etiology for 2 of the cases in the current series, should be considered in appropriate clinical situations.

Acute-onset endophthalmitis following glaucoma surgery is rare. There have been no cases at our institution since 1995. More common are cases of delayed-onset endophthalmitis associated with bleb infections in the setting of prior filtering surgery,⁴² or conjunctival erosion overlying an implanted device in the setting of prior glaucoma drainage device implantation.⁴³ Such cases from our institution have been described in earlier series.^{44,45}

When all acute-onset postoperative nosocomial endophthalmitis cases since 1995 are analyzed, 2 interesting clinical findings are appreciated. First, 13 patients underwent both aqueous and vitreous aspiration. When samples of both aqueous and vitreous are obtained in the setting of bacterial endophthalmitis, culture-positive rates have been reported to be higher in vitreous aspirates than in aqueous aspirates.⁴⁶ In accord with this, aqueous aspirates were negative in 4 cases despite positive vitreous cultures in the current study. However, there were 3 cases with positive aqueous aspirates and vitreous aspirates that were culture-negative, a situation reported by others both experimentally and related to bacterial and fungal endophthalmitis.⁴⁷⁻⁴⁹ These cases occurred following penetrating keratoplasty and glaucoma surgery in 2 instances without documented violation of the lens capsule, consistent with the notion that the intraocular infection involved primarily the anterior segment in these cases. Importantly, however, of the vitreous positive and aqueous negative cases, there were 2 cataract surgeries, 1 glaucoma surgery, and 1 PPV, suggesting that for anterior surgeries, an aqueous paracentesis may not be sufficient to identify a causative organism in all cases, in agreement with prior studies.^{46,48} Therefore whenever possible, both anterior chamber and vitreous aspirates can be performed for a complete postoperative endophthalmitis evaluation. Second, time from surgery to presentation was significantly shorter for eyes that were culture-negative (mean 4.3 days) compared to those that were culture-positive (mean 12.3 days), suggesting that at least some of the culture-negative cases may have represented cases of toxic anterior segment syndrome or similar noninfectious inflammation.⁵⁰

The frequency of postoperative endophthalmitis is low and has not increased at this university teaching hospital over the last 25 years, during which cataract surgeons have transitioned to using primarily clear corneal sutureless wounds. Most importantly, the frequency of acute-onset postoperative endophthalmitis has decreased over this time period.

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Biosketch

Harry W. Flynn, Jr, MD, is Professor of Ophthalmology at the Bascom Palmer Eye Institute, University of Miami School of Medicine, Miami, Florida, and holds the J. Donald M. Gass Distinguished Chair. Dr. Flynn served as principal investigator for the Early Treatment of Diabetic Retinopathy Study and is on the Data and Safety Monitoring Board for the Diabetic Retinopathy Research Network. He has authored numerous publications on diabetic retinopathy and vitreo-retinal surgery.



Biosketch

Charles C. Wykoff, MD, PhD, is Chief Resident at Bascom Palmer Eye Institute, Miami, Florida (2010–2011). He received his undergraduate degree in Biology from the Massachusetts Institute of Technology, Doctor of Philosophy in microbiology from Oxford University while on a Marshall Scholarship and his medical degree from Harvard Medical School. After internship at the Brigham and Women's Hospital he completed ophthalmology residency and vitreoretinal fellowship at Bascom Palmer Eye Institute. He is a Heed Fellow and his research interests pertain to adult and pediatric vitreoretinal surgical topics, endophthalmitis and macular holes.