Purposes of the current study were 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. 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
been reported previously.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.

\section*{RESULTS}

\textbf{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

\begin{table}[h]
\centering
\caption{Demographics, Clinical Features, and Culture Data for Patients With Acute-Onset Postoperative Endophthalmitis (2002–2009)}
\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
Patient (Eye, Age\textsuperscript{a}) & Year & Surgery & Intraoperative Complications & Days to Diagnosis & Aqueous Culture & Vitreous Culture & Organism Cultured \\
\hline
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 & 23 & + & NP & Strep mitis \\
11 (OD,61) & 2008 & PK & & 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 \\
\hline
\end{tabular}
\textsuperscript{a}Age is in years at time of endophthalmitis diagnosis.
\end{table}
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 = 3), polytrim (n = 2), gentamicin (n = 1), tobramycin (n = 1), or neomycin and polymyxin B (n = 1); 7 were given subconjunctival injection of ceftazolin (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 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.

A 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. Preparing 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 hypopyon (Table 3). Intravitreal vancomycin and cefta-
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).

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

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

**COMPARISON WITH PRIOR ENDOPTHALMITIS DATA FROM THE SAME INSTITUTION:** Endophthalmitis rates from 1984 to 1994\(^4\) and from 1995 to 2001\(^5\) 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 (16%) 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 Canada\(^20\) 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

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

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Cataract</td>
<td>3/41 654 (0.08)</td>
<td>8/21 972 (0.04)</td>
<td>8/29 568 (0.03)</td>
<td>.002</td>
</tr>
<tr>
<td>Pars plana vitrectomy</td>
<td>3/6557 (0.05)</td>
<td>2/7429 (0.03)</td>
<td>2/18 492 (0.01)</td>
<td>.09</td>
</tr>
<tr>
<td>Glaucoma</td>
<td>4/3233 (0.12)</td>
<td>4/1970 (0.20)</td>
<td>0/5041 (0)</td>
<td>.03</td>
</tr>
<tr>
<td>Penetrating keratoplasty</td>
<td>5/2805 (0.18)</td>
<td>2/2362 (0.08)</td>
<td>3/2788 (0.11)</td>
<td>.46</td>
</tr>
<tr>
<td>Secondary intraocular lens</td>
<td>5/1367 (0.37)</td>
<td>1/485 (0.21)</td>
<td>1/1783 (0.06)</td>
<td>.05</td>
</tr>
<tr>
<td>Total</td>
<td>54/58 123 (0.09)</td>
<td>17/35 916 (0.05)</td>
<td>14/56 672 (0.03)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

\(*Frequency data presented as a percentage of all cases performed.\)

\(^b\)Data from 1984–1994 and 1995–2001 from published manuscripts from the same institution.\(^4,5\)

\(^c\)Cochran–Armitage trend test.
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 overlaying 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.
REFERENCES


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.
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