CLINICAL STUDY

New patterns of infecting organisms in late bleb-related endophthalmitis: a ten year review

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Abstract

Purpose **To report the risk factors, causative organisms and visual outcomes in patients with late-onset bleb-related endophthalmitis.**
Methods **Medical records of all patients with the clinical diagnosis of late-onset bleb-related endophthalmitis undergoing vitreous aspirates for culture at our institution from January 1987 to July 1996 were reviewed. Late-onset bleb-related endophthalmitis was defined as conjunctival injection, bleb purulence and intraocular inflammation developing at least 1 month following filtering surgery.**
Results **Forty-nine cases of bleb-related endophthalmitis developed in 42 patients (23 men, 19 women). Mean patient age was 62.1 ± 19.3 years (range 5–94 years). Thirty-nine patients underwent prior filtering surgery (superior trabeculectomy, 24 eyes; inferior trabeculectomy, 10 eyes; combined superior trabeculectomy/cataract extraction, 4 eyes; posterior lip sclerectomy, 1 eye) and 3 had inadvertent blebs following cataract extraction. Endophthalmitis developed an average of 25.4 ± 23.5 months (range 1–96 months) post-operatively. Antifibrosis agents were used in 25 of 39 eyes undergoing filtering surgery (mitomycin C, 13 eyes; 5-fluorouracil, 12 eyes). Bleb leaks were documented in a total of 32 of 49 (65%) cases either before or at the time of endophthalmitis diagnosis. Vitreous cultures were positive in 42 of 49 (86%) cases. The most frequently cultured organisms were *Staphylococcus aureus* (13), *Staphylococcus epidermidis* (12), *Streptococcus* species (8) and *Haemophilus influenzae* (2). A final visual acuity of 20/400 or better was achieved in 32 of 49 (65%) cases.**
Conclusions **Staphylococcal species were the most frequently cultured organisms in this series and may be associated with better visual outcomes. Although a causal relationship cannot be established, these results suggest a strong association between bleb leaks and endophthalmitis.**

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Late-onset bleb-related endophthalmitis (BRE) is a devastating complication of filtering surgery.[1–10] Unlike acute post-operative endophthalmitis, which results from direct intraoperative inoculation of micro-organisms, late-onset BRE follows transconjunctival migration of bacteria into the eye.[5,11,12] Previous studies have suggested a diverse group of risk factors such as inferior bleb location,[5,11–13] blepharitis or conjunctivitis,[2,4,5,7,12,14–17] ocular trauma,[1,2,10,12] nasolacrimal duct obstruction,[4,18] contact lens use,[1–4,14,15,17,19,20] chronic bleb leak,[1,2,11,15] male gender[11] and young age.[11]

Although antifibrosis therapy with 5-fluorouracil (5-FU) and mitomycin C (MMC) was initially reserved for patients with filtration failure or previous surgery, these agents are now being increasingly applied in initial trabeculectomy in adults. With the increased use of antifibrosis agents in filtration surgery, additional concerns have been raised regarding the increased risk of late bleb leaks and endophthalmitis in these eyes. The purpose of this investigation was to describe the risk factors, spectrum of infecting micro-organisms and visual outcomes associated with late-onset BRE at our institution.

Patients and methods

The clinical and laboratory records of all patients with the diagnosis of late-onset BRE who had had intraocular cultures performed at The New York Eye and Ear Infirmary between January 1987 and July 1996 were reviewed. Late-onset BRE was defined as bleb purulence, surrounding conjunctival inflammation and cells in the anterior chamber or vitreous developing at least 1 month after filtering surgery.

Data abstracted from the medical records included age, race, sex, type of surgical procedure, interval from surgery to infection,

predisposing risk factors (position of the bleb, presence of an aqueous leak, bleb manipulation, conjunctivitis or blepharitis, contact lens use, ocular trauma) and ocular findings at the time of presentation (lens status, anterior and/or posterior segment inflammation). Snellen visual acuity and intraocular pressure (IOP) data were recorded for all patients 6 months before diagnosis, at the time of diagnosis, after treatment and 6 months following the infection. Microbiology records were reviewed for all patients. Ocular cultures were considered positive if: (1) there was growth of the same organism on two or more media (chocolate agar, blood agar, anaerobic agar, Sabouraud's dextrose agar or thioglycollate), (2) there was semi-confluent growth on one solid medium, or (3) there was growth at the inoculation site on one medium confirmed by organisms seen on Gram or Giemsa stain.

There was no standard treatment protocol. Treatment consisted of vitreous biopsy or pars plana vitrectomy and intravitreal antibiotics. Additionally, topical or intravitreal steroids and subconjunctival, topical, oral and intravenous antibiotics were administered at the discretion of the treating physician.

Table 1. *Patient demographics*

No. of eyes	42
No. of infections	49
Age (years)	62.1 ± 19.3
(range)	(5–94)
Gender	
Male	23 (55%)
Female	19 (45%)
Race	
Caucasian	23 (55%)
African-American	12 (29%)
Hispanic	5 (12%)
Asian	2 (5%)
Eye	
Right	23 (55%)
Left	19 (45%)
Follow-up (months)	
(range)	38.6 ± 30.1
	(3–114)
Surgery	
Glaucoma filtering surgery	39 (93%)
Superior trabeculectomy	24
Inferior trabeculectomy	10
Combined procedure	4
Posterior lip sclerectomy	1
Filtering surgery without antifibrosis agents	14 (33%)
Filtering surgery with antifibrosis agents	25 (60%)
5-FU	12
MMC	13
Cataract surgery (inadvertent filtering bleb)	3 (7%)
Time to BRE (all eyes) (months)	25.4 ± 23.5
(range)	(1–96)
Filtering surgery without antifibrosis agents	26.2 ± 25.7
	(1–96)
Filtering surgery with	
5-FU	30.4 ± 29.0
	(1–96)
MMC	16.3 ± 12.5
	(1–38)
Cataract surgery	33.75 ± 12.8
	(22–52)

BRE, bleb-related endophthalmitis.

LogMAR conversions of visual acuity were calculated for statistical correlations. Continuous variables were compared by Student's *t*-test.

Results

Forty-nine cases of BRE developed in 42 eyes during the course of study. A second episode of endophthalmitis developed in 7 eyes after a quiescent period of at least 3 months. One patient went on to develop a third episode. The demographic and surgical data are summarised in Table 1.

BRE developed an average of 25.4 ± 23.5 months after filtering surgery (range 1–96 months). The average time to infection onset was 30.4 ± 29.0 months (range 1–96 months) in eyes receiving adjunctive 5-FU and in eyes that received MMC was 16.3 ± 12.5 months (range 1–38 months) ($p = 0.09$).

The most frequent presenting complaints were ocular pain (71%) and redness (53%) developing within 3 days of presentation. Blurring of vision (35%), tearing (12%), purulent discharge (12%) and photophobia (10%) were also reported. Clinical findings included anterior chamber inflammation in 46 of 49 (94%) cases and vitritis in 28 of 49 (57.1%) cases. At the time of the initial infection, 19 of 42 (45%) eyes were phakic, 22 of 42 (52%) were pseudophakic and 1 of 42 (2%) was aphakic.

Risk factors for infection are summarised in Table 2. Bleb leaks were documented in 32 of 49 (65%) cases either before or at the time of endophthalmitis diagnosis. Of the 32 eyes with leaks, an antecedent bleb leak was documented 4 weeks prior to the development of BRE, as well as at the time of diagnosis, in 19 eyes (65%). Four of 32 (12%) patients presented with antecedent bleb leaks only, and 9 of 32 (28%) with bleb leaks only at the time of presentation. Of the 32 patients who had leaking blebs, 13 (41%) had received adjunctive 5-FU chemotherapy and 7 (22%) had received adjunctive MMC chemotherapy. Although conjunctivitis was documented in 4 eyes, the presence of blepharitis could not be reliably determined because of the retrospective nature of the study.

In 11 of 49 (22%) cases there was a history of bleb manipulation in the 2 weeks prior to the development of the infection (bleb needling, suture lysis or bandage contact lens wear). An episode of mucopurulent conjunctivitis that could be temporally separated from the redness and discharge accompanying the onset of endophthalmitis was present in 4 (8%) cases. There was a

Table 2. *Factors associated with late bleb-related endophthalmitis*

Risk factor	No. of cases/eyes
Bleb leak	32/49 cases (65%)
Bleb manipulation (bleb needling, suture lysis, contact lens)	11/49 cases (22.5%)
Inferior bleb location	10/42 eyes (23.8%)
Contact lens use (cosmetic)	8/49 cases (16%)
Conjunctivitis	4/49 cases (8%)
Trauma	1/49 cases (2%)

Table 3. *Patient data*

Case no.	Age (years)	Prior surgery	Bleb site	Antifibrosis agent	Time to BRE (months)	Risk factor	Infecting organism	(VA-1) LogMAR	(VA-2) LogMAR	(VA-3) LogMAR	Δ LogMAR	IOP-1	IOP-2	IOP-3
1[a]	68	CP	S	—	5	M	Coag. neg. staph.	(20/400) 1.3	(HM) 3.0	(CF) 2.8	1.5	12	10	3
2	59	Trab	S	—	36	L	Coag. neg. staph.	(CF) 2.6	(LP) 4.0	(CF) 2.6	0	6	8	22
3	9	Trab	S	MMC	4	L	Coag. neg. staph.	(20/25) 0.1	(20/30) 0.2	(20/25) 0.1	0	10	7	15
4	72	Trab	S	—	13	—	Coag. neg. staph.	(20/25) 0.1	(20/25) 0.1	(20/25) 0.1	0	7	22	15
5	45	Trab	S	5-FU	96	L	Coag. neg. staph.	(20/20) 0	(HM) 3.0	(20/20) 0	0	3	10	9
6[b]	38	Trab	I	5-FU	60	L, M, CL	Coag. neg. staph.	(20/50) 0.4	(LP) 4.0	(20/50) 0.4	0	2	17	28
7	60	PLS	S	—	36	L, C	Coag. neg. staph.	(20/20) 0	(20/60) 0.5	(20/40) 0.3	0.3	10	10	10
8	83	Trab	I	5-FU	25	M, C	Coag. neg. staph.	(CF) 2.6	(CF) 2.6	(CF) 2.6	0	8	15	18
9	6	Trab	S	MMC	26	—	Coag. neg. staph.	(20/60) 0.5	(20/80) 0.60	(20/60) 0.5	0	12	12	8
10	47	Trab	S	—	24	—	Coag. neg. staph.	(20/200) 1.0	(CF) 2.6	(20/200) 1.0	0	20	24	32
11	59	CE	S	—	31	—	Coag. neg. staph.	(20/200) 1.0	(HM) 3.0	(20/400) 1.3	0.3	10	32	12
12[c]	59	CE	S	—	20	—	Coag. neg. staph.	(20/25) 0.1	(20/40) 0.3	(20/25) 0.1	0	18	16	22
13[d]	80	Trab	I	5-FU	41	L	*S. aureus*	(20/160) 0.8	(HM) 3.0	(20/400) 1.3	0.5	12	3	8
14[d]	81	Trab	I	5-FU	13	L	*S. aureus*	(20/100) 0.7	(20/200) 1.0	(20/100) 0.7	0	8	5	17
15	63	Trab	S	MMC	2	L	*S. aureus*	(20/60) 0.5	(20/100) 0.7	(20/60) 0.5	0	7	15	10
16	47	Trab	I	MMC	38	L, M	*S. aureus*	(20/25) 0.1	(20/80) 0.6	(20/25) 0.1	0	16	11	25
17	63	Trab	S	—	16	L, M, CL	*S. aureus*	(20/40) 0.3	(20/30) 0.2	(20/50) 0.4	0.1	5	19	3
18	86	Trab	I	5-FU	11	L	*S. aureus*	(20/80) 0.6	(HM) 3.0	(NLP) 5.0	4.4	9	7	7
19	67	Trab	S	—	28	L, M, CL	*S. aureus*	(20/70) 0.5	(HM) 3.0	(NLP) 5.0	4.5	6	21	2
20[b]	37	Trab	I	5-FU	48	L, M	*S. aureus*	(20/40) 0.3	(HM) 3.0	(20/60) 0.5	0.2	5	10	7
21	71	Trab	S	—	19	L	*S. aureus*	(20/50) 0.4	(LP) 4.0	(20/200) 1.0	0.6	22	20	23
22	71	COMB	S	MMC	18	—	*S. aureus*	(20/60) 0.5	(LP) 4.0	(20/400) 1.3	0.8	10	7	9
23	71	CE	S	—	52	L	*S. aureus*	(CF) 2.6	(LP) 4.0	(LP) 4.0	1.4	18	8	6
24	41	Trab	S	—	24	L	*S. aureus*	(20/200) 1.0	(CF) 2.6	(20/400) 1.3	0.3	14	15	14
25	70	Trab	S	MMC	1	—	*S. aureus*	(20/400) 1.3	(LP) 4.0	(LP) 4.0	2.7	20	16	16
26	75	Trab	S	—	1	L, CL	*S. viridans*	(20/30) 0.2	(LP) 4.0	(LP) 4.0	3.8	14	26	10
27	84	Trab	S	MMC	19	L	*S. viridans*	(20/40) 0.3	(HM) 3.0	(20/50) 0.4	0.1	5	7	5
28	78	Trab	I	MMC	23	L	*S. viridans*	(HM) 3.0	(HM) 3.0	(NLP) 5.0	2.0	11	10	12
29	86	Trab	S	—	60	L	*S. viridans*	(20/200) 1.0	(LP) 4.0	(NLP) 5.0	4	8	8	9
30	78	Trab	S	—	36	L	*S. pneumoniae*	(LP) 4.0	(LP) 4.0	(LP) 4.0	0	24	10	38
31[a]	68	Trab	S	—	3	L, M	*S. pneumoniae*	(20/400) 1.3	(20/40) 0.30	(20/800) 1.5	0.2	14	10	24
32	61	Trab	S	5-FU	14	CL	*S. pneumoniae*	(20/40) 0.3	(20/60) 0.5	(HM) 3.0	2.7	15	14	14
33	59	CP	S	MMC	10	L, CL, C	*S. pyogenes*	(20/30) 0.2	(HM) 3.0	(20/100) 0.7	0.5	8	2	9
34	54	Trab	S	MMC	3	M, CL	*H. influenzae*	(HM) 3.0	(LP) 4.0	(LP) 4.0	1.0	25	16	14
35	89	CP	S	5-FU	35	—	*H. influenzae*	(20/30) 0.2	(HM) 3.0	(20/80) 0.6	0.4	30	21	12
36[e]	28	Trab	S	5-FU	6	L, T	*Acinetobacter*	(20/60) 0.5	(20/60) 0.5	(20/60) 0.5	0	8	8	8
37[e]	32	Trab	S	5-FU	13	L, C	*Acinetobacter*	(20/60) 0.5	(HM) 3.0	(20/60) 0.5	0	18	12	10
38	94	Trab	S	MMC	23	—	*Moraxella*	(20/50) 0.4	(LP) 4.0	(20/50) 0.4	0	13	9	15
39	57	Trab	S	MMC	23	—	*Moraxella*	(20/40) 0.3	(HM) 3.0	(20/40) 0.3	0	17	10	20
40	44	Trab	I	5-FU	77	L, CL	*Serratia*	(20/30) 0.2	(20/150) 0.9	(20/50) 0.4	0.2	20	12	8
41	82	Trab	S	—	96	L	*Neisseria*	(20/800) 1.5	(LP) 4.0	(CF) 2.6	1.1	14	28	19
42[c]	60	CE	S	—	30	—	*Lactobacillus*	(20/25) 0.1	(HM) 3.0	(20/25) 0.1	0	18	14	12
43	74	Trab	S	MMC	3	L	No growth	(20/25) 0.1	(20/300) 1.2	(20/60) 0.5	0.4	24	5	12
44	63	Trab	I	—	6	—	No growth	(20/70) 0.5	(HM) 3.0	(20/400) 1.3	0.8	18	18	14
45	76	Trab	I	5-FU	2	L, M	No growth	(20/30) 0.2	(20/60) 0.5	(20/30) 0.2	0	22	35	15
46	70	Trab	I	5-FU	1	L, M	No growth	(20/150) 0.9	(CF) 2.8	(20/150) 0.9	0	3	10	43
47[f]	70	Trab	I	5-FU	8	L	No growth	(20/40) 0.3	(HM) 3.0	(20/40) 0.3	0	12	16	12
48[f]	59	Trab	S	5-FU	62	L	No growth	(CF) 2.6	(LP) 4.0	(LP) 4.0	1.4	16	16	10
49[d]	77	Trab	I	5-FU	5	—	No growth	(20/150) 0.9	(20/400) 1.3	(CF) 2.6	1.7	43	22	19

[a,b,c,d,e,f]Episodes of BRE in the same eye of the same patient.

CP, combined procedure; Trab, trabeculectomy; PLS, posterior lip sclerectomy; CE, cataract extraction; S, superior; I, inferior; MMC, mitomycin C; 5-FU, 5-fluorouracil; L, leak; M, bleb manipulation; CL, contact lens use; C, conjunctivitis; T, trauma; Coag. neg. staph., coagulase-negative staphylococci; VA, visual acuity; IOP, intraocular pressure; −1, six months prior to infection; −2, at the time of infection;

Table 4. *Reported series of late bleb-related endophthalmitis*

		Positive intraocular cultures		Staphylococcal cases		Streptococcal cases		Final VA ⩾ 20/400					
								All eyes		Staphylococci		Streptococci	
Reference	*n*	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Mandelbaum *et al.* (1985)[5]	36	30	(83)	2	(7)	17	(57)	11/36	(31)	1/2	(50)	3/17	(18)
Phillips *et al.* (1994)[10]	18	12	(67)	7	(58.2)	4	(25)	8/18	(44)	5/7	(71.4)	0/4	(0)
Greenfield *et al.* (1996)[12]	13	9	(69)	1	(7.7)	3	(23.1)	8/13	(62)	1/1	(100)	2/3	(67)
Kangas *et al.* (1997)[9]	32	31	(97)	7	(23)	15	(48)	15/32	(47)	5/7	(71.4)	6/15	(40)
Waheed *et al.* (1998)[8]	49	42	(86)	25	(56)	8	(19)	31/49	(65)	18/25	(72)	2/8	(25)

history of refractive contact lens use at the time of development of endophthalmitis in 8 (16%) cases, and blunt trauma 4 days prior to infection in 1 (2%) case.

Intraocular antibiotics were administered in all 49 cases. In 37 of 49 (75%) cases dexamethasone (360 μg) was injected intravitreally. Vitreous cultures were performed in all cases and anterior chamber cultures were performed in 47 of 49 (96%) cases. Vitreous aspiration was performed in 22 of 49 (48%) cases and pars plana vitrectomy was performed in 27 of 49 (55%) cases. In 24 cases vitrectomy was performed as part of the initial procedure while in 3 cases it was performed as a secondary procedure. During the hospitalisation, 8 of 49 (16%) eyes underwent a second surgical procedure (repeat pars plana vitrectomy, 4; pars plana lensectomy, 2; choroidal drainage, 1; reformation of the anterior chamber, 1) after failure of the initial procedure to control the acute infection or to address the sequelae of infection.

Vitreous cultures were positive in 42 of 49 (86%) cases. Staphylococcal species were isolated in 25 of 42 (59%) cases (*Staphylococcus aureus*, 13; coagulase-negative staphylococci, 12) and streptococcal species were recovered from 8 of 42 (19%) eyes (*Streptococcus viridans*, 4; *Streptococcus pneumoniae*, 3; *Streptococcus pyogenes*, 1). The remaining isolates included *Haemophilus influenzae* (2), *Acinetobacter* (2), *Moraxella liquefaciens* (1), *Moraxella lacunata* (1), *Neisseria subflava* (1), *Lactobacillus casei* (1) and *Serratia marcescens* (1). Bleb surface cultures were obtained in 7 cases. In 5 of 7 (71%) cultures the same micro-organism was isolated from the intraocular and extraocular cultures.

The mean decrease in logMAR acuity after treatment of bleb-related endophthalmitis was 0.77 ± 1.25 (range 0–4.46). The final visual acuity was better than or equal to 20/40 in 10 of 49 (20%) cases, 20/100 in 24 (49%) and 20/400 in 32 (65%) cases. In cases caused by staphylococcal species, 18 of 25 (72%) retained vision better than or equal to 20/400. The mean decrease in logMAR vision after infection with coagulase-negative staphylococci was less (0.2) than that with *Staphylococcus aureus* (1.2). In cases caused by *Streptococcus*, 2 of 8 (25%) retained vision better than or equal to 20/400. The mean decrease in logMAR vision after infection with *Streptococcus viridans* was greater (2.5) than that with *Streptococcus pneumoniae* and *Streptococcus pyogenes* (0.9). There was no statistically significant change in mean IOP before and after BRE (13.7 ± 7.9 mmHg (range 2–43 mmHg) vs 14.4 ± 8.6 mmHg (range 2–43 mmHg)) ($p = 0.6$). Patients were using a mean of 0.6 ± 1.1 medications (range 0–4) before infection and 1.0 ± 0.9 medications (range 0–3) after infection.

Comment

Late-onset BRE has been reported to occur in 0.2–9.6% of patients following glaucoma filtering surgery.[1,2,4,11,12,21] Infection may occur months to years after filtering surgery, and may result in the loss of useful vision.[1–4,7,15,22] With the increased use of adjunctive antifibrotic agents in glaucoma filtration surgery there has been heightened concern about the resultant thin-walled blebs, which are thought to be more susceptible to infection than those with thicker walls.[11–13]

The microbiological spectrum of organisms isolated in our series differs from that in previous studies. The majority of infections in our patients were due to staphylococcal species, rather than streptococci as previously reported.[5,9,11,12] Staphylococcal species have been reported to be the most commonly isolated organism in acute post-operative endophthalmitis,[23–25] particularly following cataract surgery,[26] and may be associated with better visual outcomes than streptococci.[27–29] Unlike streptococcal species, staphylococci do not produce exotoxins and do not have the ability to penetrate intact conjunctiva. The high incidence of *Staphylococcus*-related BRE in our series may be associated with the large number of conjunctival bleb leaks (65% eyes) that may provide direct intraocular access. An alternative hypothesis is that geographic differences may account for the varied spectrum of microbial pathogens observed. Whether conjunctival leaks precede bleb infection or result from it remains speculative. Although our data suggest a strong association between bleb leaks and endophthalmitis, a causal relationship can only be established following a prospective clinical trial.

Visual outcomes following treatment for BRE are generally poor.[1–5,9,12,13,17,22] Wolner *et al.*[11] reported visual acuity better than 20/400 in 84% of eyes with late-

onset BRE and speculated that early detection, before active vitreous involvement, was a significant factor in their series. Other authors have attributed better visual outcome to lower virulence of infecting organisms[10] and aggressive, prompt intervention.[3]

In our series, 49% of eyes retained 20/100 vision, and 65% retained visual acuity better than or equal to 20/400. These overall outcomes are similar to previous reports. However, if the cases of staphylococcal endophthalmitis are evaluated independently, 18 of 25 (72%) had a final visual acuity of 20/400 or better which is comparable to the visual outcomes after treatment for acute endophthalmitis following cataract extraction caused by coagulase-negative *Staphylococcus* species.[26,29] As previously reported,[30] we found better visual outcomes among eyes after infection with coagulase-negative *Staphylococcus* compared with *Staphylococcus aureus*. Our visual results were less encouraging for *Streptococcus* species and *Haemophilus influenzae*, in which 3 of 10 (30%) patients had a final visual acuity of 20/400 or better. There are inherent difficulties in attempting to correlate final visual outcome with the infecting microbial pathogen, as other variables may be involved. The amount of pre-existing glaucomatous optic nerve damage, diagnostic delay, antimicrobial resistance and intravitreal inflammatory response may all affect visual outcomes.

In all but 9 cases the IOP did not rise significantly after the resolution of the infection. The IOP remained controlled without any antiglaucomatous medication, or no increase in medication, in 26 of 49 (53%) eyes. As previously reported,[11,12] this suggests that most blebs continue to function after treatment and may remain at risk for repeated infectious episodes.

Filtering bleb leaks were very common in this series. Although some authors have described a high incidence of bleb leaks in eyes with BRE,[11] others have found no such association.[5,12] In agreement with previous reports, bleb manipulation, inferior bleb location and the use of contact lenses were also associated with BRE.[2,5,12,14,19,20]

Although 86% of our cases had positive vitreous cultures, 43% demonstrated no vitreous cellular reaction at the time of presentation. This suggests that early posterior segment infection may occur in eyes with isolated anterior segment inflammation. In light of these results, we recommend extremely close in-patient or out-patient observation in eyes with bleb purulence, a clear vitreous cavity and anterior segment inflammation, and treatment with frequently administered fortified topical antibiotics. If no clinical improvement is observed over the following 24–48 h (e.g. a decrease in the anterior chamber reaction and/or improvement in visual acuity) or inflammation is detected in the vitreous cavity at any time, vitreous biopsy is recommended with intravitreal antibiotic administration.

In summary, this series is the first to document *Staphylococcus* species as an important cause of late-onset bleb-related endophthalmitis. Since these pathogens may exhibit less virulence than *Streptococcus* and *Haemophilus* species, the potential for visual recovery may be greater. Visual outcomes associated with coagulase-negative staphylococci are better than with *Staphylococcus aureus*. It remains unclear, however, whether geographic variability may account for the differences observed in microbial pathogens. Risk factor reduction, education of patients regarding symptoms, early recognition of clinical signs, and appropriate, timely intervention may help to reduce the impact of this sight-threatening complication.

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