Published in final edited form as:
Am J Ophthalmol. 2014 April ; 157(4): 774–780.e1. doi:10.1016/j.ajo.2013.12.026.

Endophthalmitis Caused by Streptococcal Species: Clinical Settings, Microbiology, Management, and Outcomes

Ajay E. Kuriyan[1], **Kathleen D. Weiss**[1], **Harry W. Flynn Jr.**[1], **William E. Smiddy**[1], **Audina M. Berrocal**[1], **Thomas A. Albini**[1], and **Darlene Miller**[1]

[1]Department of Ophthalmology, Bascom Palmer Eye Institute, University of Miami, Miami, FL

Abstract

Purpose—To report the clinical settings, antibiotic susceptibilities, and outcomes of endophthalmitis caused by *Streptococcus* species.

Study Design—Retrospective, observational case series.

Methods—Single-center study evaluating all patients with culture-positive endophthalmitis caused by *Streptococcus* species between January 1, 2000 and December 31, 2011.

Results—Study criteria were met by 63 patients. The most common clinical settings were bleb-associated (17, 27%), post-intravitreal injection (16, 25%), and post-cataract surgery (13, 21%). The isolates were *S. viridans* (47, 71%), *S. pneumoniae* (13, 21%), and β-hemolytic *Streptococci* (5, 8%). Sixty (95%) of 63 isolates were susceptible to vancomycin, 47 (98%) of 48 to ceftriaxone (third generation cephalosporin), and 57 (93%) of 61 to levofloxacin (third generation fluoroquinolone). Between the first and second half of the study period, the minimal inhibitory concentration (MIC) of antibiotics required to inhibit 90% of isolates increased by 1.5-fold for ceftriaxone and 2-fold for levofloxacin, and remained the same for vancomycin. Initial treatment was vitreous tap (49, 78%) or pars plana vitrectomy (14, 22%); all received intravitreal antibiotics. Visual acuity outcomes were variable; best corrected visual acuity (BCVA) was ≥20/400 in 16 (25%) patients and <20/400 in 47 (75%) patients. Evisceration/enucleation was performed in 16 (25%) patients.

Conclusion—*Streptococcus* isolates generally had high susceptibility rates to commonly used antibiotics. Higher antibiotic MICs were required to inhibit 90% of isolates *in vitro* in the second half of the study period compared to the first half. Despite prompt treatment, the majority of patients had poor outcomes.

Corresponding Author: Ajay E. Kuriyan, MD, 900 NW 17th Street, Miami, FL 33136, akuriyan@med.miami.edu, Tel: 305-326-6000, Fax: 305-326-6417.

Disclosures: All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest. A.E.K.: None, K.D.W.: None, H.W.F.: Consultant for Santen, Vindico, DM: None, W.E.S.: Consultant for Alimera Scientific, A.M.B.: None, T.A.A.: Consultant for Allergan, Bausch and Lomb, Eleven Biotherapeutics, and Thrombogenics

Contributions of Authors: Conception and design (A.E.K., H.W.F., D.M.); Analysis and interpretation of the data (A.E.K., K.D.W., H.W.F., D.M.); Writing the article (A.E.K., K.D.W.); Critical revision of the article (A.E.K., K.D.W., H.W.F., W.E.S., A.M.B., T.A.A., D.M.); Final approval of the article (A.E.K., K.D.W., H.W.F., W.E.S., A.M.B., T.A.A., D.M.); Data collection (A.E.K., K.D.W., D.M.); Provision of patients, materials, or resources (A.E.K., K.D.W., H.W.F., W.E.S., A.M.B., T.A.A., D.M.); Statistical expertise (A.E.K.); Obtaining funding (H.W.F., D.M), Literature search (A.E.K., H.W.F., D.M.), Administrative, technical, or logistical support (A.E.K., K.D.W., H.W.F., D.M.).

Introduction

Endophthalmitis is a severe sight-threatening ocular infection caused by a variety of microbes.[1, 2] *Streptococcus* is a common cause of endophthalmitis after glaucoma filtering surgery[3, 4] and endogenous bacterial endophthalmitis.[5] *Streptococcus* is also the second most common genus of organisms identified in endophthalmitis post-cataract surgery[2, 6–8] and post-intravitreal anti-vascular endothelial growth factor (VEGF) injection.[1, 6, 9–13] In previous reports, endophthalmitis cases caused by *Streptococcus* species have poorer visual outcomes compared to coagulase-negative *Staphylococcus* species, the most common cause of postoperative endophthalmitis overall.[3, 14, 15]

A previous study from 1977 to 1990 from our institution reported clinical settings, antibiotic susceptibilities, and treatment outcomes for endophthalmitis caused by *Streptococcus* species.[14] Since then, there has been a dramatic rise in the number of intravitreal injections performed.[10, 11] Additionally, *Enterococcus faecalis*, which was formerly classified as a Group D *Streptococcus* species, has been reclassified under the distinct *Enterococcus* genus.[14,16] There have also been reports of increased antibiotic non-susceptibility among *Streptococcus* species and spread of virulence factors between the species.[17–19] The purpose of this study is to provide an update on the clinical settings, antibiotic susceptibilities and minimal inhibitory concentrations (MICs), management strategies, and visual acuity (VA) outcomes in a more recent series of culture-proven streptococcal endophthalmitis from our institution. Based on a PubMed literature search, the current study is the largest series of culture-positive endophthalmitis caused by streptococcal species.

Methods

The study protocol for a retrospective review of medical and microbiology records for all patients treated at Bascom Palmer Eye Institute with vitreous fluid culture-proven endophthalmitis caused by *Streptococcus* species between January 1, 2000 and December 31, 2011 was approved by the Institutional Review Board of the University of Miami Miller School of Medicine Medical Sciences Subcommittee for the Protection of Human Subjects. Isolates were identified using standard microbiological procedures. Shifting trends in *in vitro* MIC (μg/ml) were analyzed using the E test (Biomeriuex, Raleigh, NC). The treatment strategies were determined by the individual treating physicians and did not follow a standardized protocol.

Statistical analysis was performed using Statistical Package for the Social Sciences software (SPSS Inc, Chicago, Illinois, USA). Snellen best corrected visual acuity (BCVA) was converted to logarithm of minimal angle of resolution (logMAR) equivalents and BCVA of count fingers, hand motion, light perception, and no light perception were assigned logMAR values of 1.85, 2.3, 2.7, and 3.0, respectively, as previously described.[20–21] The logMAR BCVA is presented as mean +/− standard deviation (SD). BCVA at presentation and last follow up visit were analyzed based on the clinical setting and *Streptococcus* species group using one-way analysis of variance (ANOVA) analysis with Tukey post-hoc analysis. The Student's T-test was used to compare the VA outcomes between patients who received different initial treatment regimens. Fisher's exact test was used to compare the number of additional treatments and enucleations/eviscerations between different initial treatment regimens. Fisher's exact test was also used to compare the findings of the current study and the previously reported study on endophthalmitis due to *Streptococcus* from our institution.[14] A p-value of <0.05 was considered statistically significant.

Results

Patient demographics, ocular and medical history, and presentation

During the 12 year period, 66 patients with streptococcal endophthalmitis met the study entry criteria. Three patients were excluded from the current study due to missing medical records. Also included in this study were 11 patients who were previously described as part of a case series detailing an outbreak of *S. viridans* due to contaminated bevacizumab intravitreal injections.[22] The mean age of the patients was 66.9 years (median: 73, range 3 to 92). There were 37 (58.7%) males and 23 (37%) right eyes. Thirty-five (56%) patients had a history of hypertension and 13 (21%) had a history of diabetes mellitus. Six (10%) patients were immunocompromised from chronic systemic corticosteroids (3), chronic systemic chemotherapeutic agents (1), asplenia (1), or genetic abnormalities (1). Patients had an ocular history of glaucoma (26), age-related macular degeneration (AMD, 17) proliferative diabetic retinopathy (1), Fuchs' endothelial dystrophy (1), Peter's anomaly (1), and thyroid eye disease (1).

The clinical setting for each case is summarized in Table 1. The most common clinical scenario of streptococcal endophthalmitis in the current series was bleb-associated (17, 27%). The first case of post-intravitreal injection endophthalmitis in the current series occurred in 2007. One patient from the post-cataract surgery and post-penetrating keratoplasty/keratoprosthesis surgery groups developed endophthalmitis one day after removal of a suture. One patient in the post-penetrating keratoplasty/keratoprosthesis group had a suture abscess.

At the presenting visit, 60 (95%) of the 63 patients reported pain and 50 (79%) had a hypopyon. A view of the posterior pole was unobtainable in 57 (91%) of 63 patients due to severe anterior segment inflammation and media opacities. Vitritis was noted in all patients in which there was a view of the posterior pole.

Clinical management

The initial and subsequent clinical management of patients are summarized in Table 2. Initial treatment consisted of a vitreous tap and intravitreal antibiotics in 49 (78%) of 63 patients and pars plana vitrectomy (PPV) with intravitreal antibiotics in 14 (22%). The highest rates of additional therapeutic interventions were among the following clinical settings: post-intravitreal injection (14 of 16, 89%), post-penetrating keratoplasty/ keratoprosthesis (6 of 8, 75%), and the miscellaneous group (2 of 3, 67%). Of the 49 patients who underwent a vitreous tap and intravitreal antibiotics as initial treatment, five (10%) underwent additional intravitreal antibiotics only, seven (14%) underwent additional intravitreal antibiotics followed by a PPV on a different date, and 15 (31%) underwent a PPV with intravitreal antibiotics only. Two (14%) of 14 patients who underwent initial treatment of PPV with intravitreal antibiotics underwent subsequent vitreous tap and intravitreal antibiotics on a different date. Evisceration or enucleation was performed in 14 (29%) of 49 patients initially treated with a vitreous tap and intravitreal antibiotics compared to two (14%) of 14 patients initially treated with PPV and intravitreal antibiotics (p=0.49). Of the patients who received initial treatment with vitreous tap and intravitreal antibiotics, 34 (69%) of 49 patients had additional interventions, compared to four (29%) of 14 who were initially treated with PPV and intravitreal antibiotics (p=0.01).

Vancomycin was used for intravitreal antibiotic treatment in all patients and a second intravitreal antibiotic (ceftazidime or amikacin) was used in 61 (97%) of 63. The only two patients who did not receive a second antibiotic were part of an outbreak of vancomycin-susceptible *S. viridans* due to contaminated bevacizumab intravitreal injections and

presented after identification of the causative organism in other patients.[22] Additionally, 56 (89%) of 63 patients were started on intravitreal dexamethasone as part of their initial treatment. All patients were started on topical antibiotic drops: 51 (81%) of 63 on fortified vancomycin and a second antibiotic (fortified tobramycin, fluoroquinolone, cephalosporin, or amikacin), four (6.3%) on fortified vancomycin alone, four (6.3%) on fortified tobramycin alone, two (3.2%) on a fluoroquinolone and cephalosporin, and two (3.2%) on fortified tobramycin and another antibiotic. A topical steroid drop was started within 48 hours of the initial treatment in 59 (94%) of 63 patients.

Microbiology and antibiotic susceptibility

The microbiology findings and antibiotic susceptibilities are summarized in Table 3. In the current study, *Streptococcus* species were grouped as previously described by Mao and colleagues: 1) *S. viridans*, 2) *S. pneumoniae*, and 3) β-hemolytic *Streptococci*.[14] *S. viridans* group (45 of 63, 71%) was the most common organism isolated overall and in all the clinical scenarios, except for the miscellaneous group in which *S. pneumoniae* was isolated in all three patients. A single *Streptococcus* species was identified in 58 (92%) of 63 patients. The five polymicrobial cultures included: 1) an additional *Streptococcus* species 2) an additional *Streptococcus* species and *Bacteroides distasonis* 3) *Staphylococcus aureus*, 4) a coagulase negative *Staphylococcus* species and 5) a coagulase negative *Staphylococcus* species.

Sixty (95%) of 63 streptococcal isolates were susceptible to vancomycin, 47 (98%) of 48 were susceptible to ceftriaxone, a 3rd generation cephalosporin, and 57 (93%) of 61 were susceptible to levofloxacin, a 3rd generation fluoroquinolone (Table 3). The MIC required to inhibit 90% of streptococcal isolates for vancomycin was 1 μg/ml (range: 0.25 to 1 μg/ml) during the first six years (2000–2005) and 1 μg/ml (range: 0.38 to 1.5 μg/ml) during the second six years (2006–2011) of the study period. Between the first and second half of the study period, the MIC required to inhibit 90% of isolates increased by 1.5-fold for ceftriaxone and 2-fold for levofloxacin (Table 3).

Clinical outcomes

The median follow-up period was 15.7 months (range: 1 day to 9.8 years). The BCVA at presentation and final follow up visit for the different clinical settings and streptococcal isolates are summarized in Table 4. There was no difference in BCVA at presentation among the different clinical settings (p=0.23) or among the different *Streptococcus* species groups (p=0.36). The bleb-associated patients had better VA outcomes compared to post-intravitreal injection (p=0.001) and miscellaneous group (p=0.008) patients. Additionally, the post-cataract patients had better VA outcomes compared to the post-intravitreal injection (p=0.03) and the miscellaneous group (p=0.01) patients. There was no difference in the visual acuity outcomes among the three *Streptococcus* organism groups (p=0.87).

There was no difference (p=0.75) in the average BCVA at presentation between the patients who underwent initial treatment with vitreous tap and intravitreal antibiotics (n=49, logMAR BCVA: 2.38 +/− 0.48, Snellen BCVA equivalent ≈20/4,800) compared to compared to PPV and intravitreal antibiotics (n=14, logMAR BCVA: 2.43 +/− 0.63, Snellen BCVA equivalent ≈20/5,400). Furthermore, there was no difference (p=0.87) between the average VA outcomes of patients who underwent initial treatment with vitreous tap and intravitreal antibiotics (logMAR BCVA: 2.15 +/− 1.01, Snellen BCVA equivalent ≈20/2,800) compared to PPV and intravitreal antibiotics (logMAR BCVA: 2.20 +/− 0.85, Snellen BCVA equivalent ≈20/3,200).

There was no difference (p=0.66) in the presenting BCVA between patients who received intravitreal dexamethasone as part of their initial treatment (n=56, logMAR BCVA: 2.38 +/−

0.54, Snellen BCVA equivalent ≈20/4,800) and those who did not (n=7, logMAR BCVA: 2.47 +/− 0.21, Snellen BCVA equivalent ≈20/5,900). However, there were better VA outcomes (p=0.000) in patients who received intravitreal dexamethasone as part of their initial treatment (logMAR BCVA: 2.07 +/− 0.99, Snellen BCVA equivalent ≈20/2,300) compared to those who did not (logMAR BCVA: 2.87 +/− 0.16, Snellen BCVA equivalent ≈20/15,000).

Discussion

Bleb-associated and post-intravitreal injection are the two most common clinical settings for *Streptococcus* endophthalmitis in the current series. The current study demonstrates that *Streptococcus* endophthalmitis has poor visual outcomes, despite prompt and appropriate treatment. Of note, bleb-associated and post-cataract patients had better VA outcomes than post-intravitreal injection and miscellaneous group patients. Potential causes for worse VA outcomes in post-intravitreal injection cases include direct inoculation of the vitreous cavity with bacteria and a higher concentration of bacteria with contaminated intravitreal medications.[23, 24] Additionally, there were better VA outcomes in patients who received intravitreal dexamethasone as part of their initial treatment compared to patients who did not, which is consistent with previous studies on the use of intravitreal corticosteroids in bacterial endophthalmitis.[25, 26] Initial treatment with two intravitreal antibiotic agents (vancomycin and an antimicrobial with both gram positive and negative organism coverage) is important as one of the five polymicrobial cultures in our series was a gram negative rod (*Bacteroides distasonis*), which would not have been adequately treated by vancomycin alone and there were three isolates that were vancomycin non-susceptible.

The findings of the current study and the Mao, *et al* study are compared in Table 5.[14] Of note, the most common etiology in the current series is bleb-associated compared to post-cataract surgery in the Mao series.[14] *E. faecalis* was the second most common isolate in the Mao series, but was not included in the current series due to its reclassification as a separate genus.[16] Despite a shorter study period and exclusion of *E. faecalis*, there were 15 more cases described in the current study.[14] There was a larger proportion of patients initially treated with vitreous tap and intravitreal antibiotics in the current study (49 of 63, 78%) compared to the Mao study (16 of 48, 33%, p=0.000).[14] There was also a larger proportion of patients treated with intravitreal corticosteroids in the current study (56 of 63, 89%) compared to the Mao study (8 of 48, 17%, p = 0.000).[14] The ceftriaxone susceptibility patterns were similar in both studies when excluding the *E. faecalis* isolates from the Mao series.[14] Levofloxacin susceptibility was not reported in the Mao series.[14] Sixty (95%) of 63 isolates in the current study were susceptible to vancomycin compared to 46 (100%) of 46 isolates in the Mao study.[14]

Although the *Streptococcus* isolates in the current series had high rates of susceptibility to commonly used antibiotics, the organisms had higher MICs required to inhibit 90% of streptococcal isolates in the latter part of the study for ceftriaxone and levofloxacin (Table 3). Although the MIC required to inhibit 90% of streptococcal isolates remained the same for vancomycin (1.0 μg/ml) during the first and second half of the study period, the latter half had three isolates with vancomycin inhibitory concentrations of 1.5 μg/ml, while earlier half had none. *Streptococcus* isolates are susceptible to vancomycin if the MIC is ≤1 μg/mL, when using methods published by the Clinical and Laboratory Standards Institute.[27] Non-susceptible MICs for *Streptoccocus* to vancomycin (>1 μg/mL) have not been characterized as either intermediate or resistant due to limited clinical experience with such strains.[25] All three vancomycin non-susceptible isolates were susceptible to 3rd generation cephalosporins and received initial treatment with intravitreal vancomycin and ceftazidime, a 3rd generation cephalosporin. All three required enucleation/evisceration. We are unaware of previous

reports of vancomycin non-susceptible streptococcal endophthalmitis and could find no reference to it in a computerized search (PubMed).

The limitations of the current study include its retrospective design and relatively small number of patients. In a larger prospective clinical trial, randomization might offer additional information regarding optimal treatment. A sampling bias of cases with poor initial vision might be present in the current study. Worse pre-infection VA in certain clinical settings (eg. post-intravitreal injection who were mostly wet AMD patients) may be a potential confounding factor contributing to worse VA outcomes. While the inclusion of 11 patients who were part of an outbreak of *S. viridans* endophthalmitis due to contaminated bevacizumab intravitreal injections during the study period resulted in a larger proportion of cases in this clinical setting, these cases provide important insight into the outcomes of intravitreal injection-related endophthalmitis caused by *Streptococcus* species. Positive vitreous cultures were a part of the inclusion criteria for the study, which could potentially introduce selection bias due to exclusion of false negative vitreous cultures. Additionally, cases with positive vitreous cultures may be more aggressive cases than those with negative cultures. Although the E-test provides helpful information about antibiotic susceptibility *in vitro*, clinical susceptibility to an antibiotic is determined by a variety of different patient, antibiotic, and isolate factors. Despite these limitations, this study provides important prognostic and antibiotic susceptibility data for endophthalmitis caused by *Streptococcus* species.

In conclusion, despite prompt vancomycin treatment, patients in the current study generally had poor VA outcomes, consistent with previous studies.[2, 14] The antibiotic susceptibility data from the current study further supports continued use of vancomycin as well as another antibiotic agent with both gram positive and negative coverage (eg. ceftazidime). Rising antibiotic MICs for streptococcal isolates raises concern about decreased clinical susceptibility to commonly used antibiotics now and in the future.

Acknowledgments

Financial Support: This research is funded in part by NIH Center Core Grant P30EY014801 (Bethesda, Maryland), Research to Prevent Blindness Unrestricted Grant (New York, New York), and the Department of Defense (DOD Grant #W81XWH-09-1-0675) (Washington, DC). The sponsor or funding organization had no role in the design or conduct of this research.

References

1. Kernt M, Kampik A. Endophthalmitis: Pathogenesis, clinical presentation, management, and perspectives. Clin Ophthalmol. 2010; 4:121–135. [PubMed: 20390032]
2. Endophthalmitis Vitrectomy Study Group. Results of the endophthalmitis vitrectomy study. A randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. Arch Ophthalmol. 1995; 113(12):1479–1496. [PubMed: 7487614]
3. Jacobs DJ, Leng T, Flynn HW Jr, Shi W, Miller D, Gedde SJ. Delayed-onset bleb-associated endophthalmitis: Presentation and outcome by culture result. Clinical Ophthalmology (Auckland, NZ). 2011; 5:739.
4. Song A, Scott IU, Flynn M, Budenz DL. Delayed-onset bleb-associated endophthalmitis: Clinical features and visual acuity outcomes. Ophthalmology. 2002; 109(5):985–991. [PubMed: 11986108]
5. Okada AA, Johnson RP, Liles WC, D'Amico DJ, Baker AS. Endogenous bacterial endophthalmitis. report of a ten-year retrospective study. Ophthalmology. 1994; 101(5):832–838. [PubMed: 8190467]

6. Miller JJ, Scott IU, Flynn HW Jr, Smiddy WE, Newton J, Miller D. Acute-onset endophthalmitis after cataract surgery (2000–2004): Incidence, clinical settings, and visual acuity outcomes after treatment. Am J Ophthalmol. 2005; 139(4):983–987. [PubMed: 15953426]
7. Wykoff CC, Parrott MB, Flynn HW Jr, Shi W, Miller D, Alfonso EC. Nosocomial acute-onset postoperative endophthalmitis at a university teaching hospital (2002–2009). Am J Ophthalmol. 2010; 150(3):392–398. e2. [PubMed: 20619391]
8. Barry P, Gardner S, Seal D, Gettinby G, Lees F, Peterson M, Revie CW. Clinical observations associated with proven and unproven cases in the ESCRS study of prophylaxis of postoperative endophthalmitis after cataract surgery. J Cataract Refract Surg. 2009; 35(9):1523–1531. [PubMed: 19683148]
9. Mccannel CA. Meta-analysis of endophthalmitis after intravitreal injection of anti–vascular endothelial growth factor agents: Causative organisms and possible prevention strategies. Retina. 2011; 31(4):654. [PubMed: 21330939]
10. Moshfeghi AA, Rosenfeld PJ, Flynn HW Jr, et al. Endophthalmitis after intravitreal anti-vascular endothelial growth factor antagonists: A six-year experience at a university referral center. Retina. 2011; 31(4):662–668. [PubMed: 21836400]
11. Pilli S, Kotsolis A, Spaide RF, et al. Endophthalmitis associated with intravitreal anti-vascular endothelial growth factor therapy injections in an office setting. Am J Ophthalmol. 2008; 145(5): 879–882. [PubMed: 18329624]
12. Ramakrishnan R, Bharathi MJ, Shivkumar C, et al. Microbiological profile of culture-proven cases of exogenous and endogenous endophthalmitis: A 10-year retrospective study. Eye (Lond). 2009; 23(4):945–956. [PubMed: 18600246]
13. Simunovic MP, Rush RB, Hunyor AP, Chang AA. Endophthalmitis following intravitreal injection versus endophthalmitis following cataract surgery: Clinical features, causative organisms and post-treatment outcomes. Br J Ophthalmol. 2012; 96(6):862–866. [PubMed: 22446145]
14. Mao LK, Flynn HW Jr, Miller D, Pflugfelder SC. Endophthalmitis caused by streptococcal species. Arch Ophthalmol. 1992; 110(6):798–801. [PubMed: 1596227]
15. Lemley CA, Han DP. Endophthalmitis: A review of current evaluation and management. Retina. 2007; 27(6):662–680. [PubMed: 17621174]
16. Hardie J, Whiley R. Classification and overview of the genera streptococcus and enterococcus. J Appl Microbiol. 2003; 83(S1):1S–11S.
17. Levy SB. Antibiotic resistance—the problem intensifies. Adv Drug Deliv Rev. 2005; 57(10):1446–1450. [PubMed: 15949867]
18. Liñares J, Ardanuy C, Pallares R, Fenoll A. Changes in antimicrobial resistance, serotypes and genotypes in streptococcus pneumoniae over a 30-year period. Clinical Microbiology and Infection. 2010; 16(5):402–410. [PubMed: 20132251]
19. Mitchell AM, Mitchell TJ. Streptococcus pneumoniae: Virulence factors and variation. Clin Microbiol Infect. 2010; 16(5):411–418. [PubMed: 20132250]
20. Schulze-Bonsel K, Feltgen N, Burau H, Hansen L, Bach M. Visual acuities “hand motion” and “counting fingers” can be quantified with the freiburg visual acuity test. Invest Ophthalmol Vis Sci. 2006; 47(3):1236–1240. [PubMed: 16505064]
21. Bach M, Schulze-Bonsel K, Feltgen N, Burau H, Hansen L. Author response: Numerical imputation for low vision states [electronic letter]. Invest Ophthalmol Vis Sci. 2007
22. Goldberg RA, Flynn HW Jr, Isom RF, Miller D, Gonzalez S. An outbreak of streptococcus endophthalmitis after intravitreal injection of bevacizumab. Am J Ophthalmol. 2012; 153(2):204–208. e1. [PubMed: 22264943]
23. Gonzalez S, Rosenfeld PJ, Stewart MW, Brown J, Murphy SP. Avastin doesn't blind people, people blind people. Am J Ophthalmol. 2012; 153(2):196–203. e1. [PubMed: 22264942]
24. de Caro JJ, Ta CN, Ho HK, et al. Bacterial contamination of ocular surface and needles in patients undergoing intravitreal injections. Retina. 2008; 28(6):877–883. [PubMed: 18536606]
25. Falk NS, Beer PM, Peters III GB. Role of intravitreal triamcinolone acetonide in the treatment of postoperative endophthalmitis. Retina. 2006; 26(5):545–548. [PubMed: 16770261]

26. Shah GK, Stein JD, Sharma S, et al. Visual outcomes following the use of intravitreal steroids in the treatment of postoperative endophthalmitis. Ophthalmology. 2000; 107(3):486–489. [PubMed: 10711885]

27. Clinical and Laboratory Standards Institute (CLSI). Performance standards for antimicrobial susceptibility testing: 23rd informational supplement (M100-S23). Wayne, PA: CLSI; 2013.

Biography

Ajay E. Kuriyan, MD, is an ophthalmology resident at the Bascom Palmer Eye Institute, Miami, Florida. He received his undergraduate, master's, and medical degree from the University of Rochester. His research interests include endophthalmitis, epiretinal membranes, ophthalmic imaging, ocular wound healing, and thyroid eye disease. He will begin his vitreoretinal fellowship in July 2014 at the Bascom Palmer Eye Institute.

Table 1

Clinical features of endophthalmitis caused by *Streptococcus* species.

Clinical Scenario	**Number of Patients (%)**	**Age (years)**	**Time between event and diagnosis**	**Number of *Streptococcus* Organism (% of Clinical Scenario)**		
				β-Hemolytic	***Pneumoniae***	***Viridans***
Bleb associated	17 (27)	27–92	2 m - 480 m	2 (12)	4 (23)	11 (65)
Post-intravitreal injection	16 (25)	59–88	1 d - 8 d	0 (0)	1 (6)	15 (94)
Post-cataract Sx	13 (21)	68–91	3 d - 1.5 m	1 (8)	4 (31)	8 (61)
Post-PKP/K-Pro Sx[a]	8 (13)	3–87	1 d - 157.5 m	2 (25)	1 (12)	5 (63)
Ruptured globe	4 (6)	13–51	1 d - 2 d	0 (0)	0 (0)	4 (100)
Miscellaneous[b]	3 (5)	4–63	6 d - 57 m	0 (0)	3 (100)	0 (0)
Endogenous	2 (3)	58–67	-[c]	0 (0)	0 (0)	2 (100)
TOTALS	**63 (100)**	**3–91**	**1 d - 480 m**	**5 (8)**	**13 (21)**	**45 (71)**

Legend: PKP = penetrating keratoplasty, K-Pro = Keratoprosthesis, Sx = surgery.

[a] Includes 6 PKP and 2 K-Pro patients,

[b] Includes two post-operative glaucoma drainage device patients and one perforated corneal ulcer patient,

[c] Time between the causative event and diagnosis of endophthalmitis was not able to be determined.

Table 2

Clinical management of patients with endophthalmitis caused by *Streptococcus* species.

Clinical Scenario (No.)	Number of Initial Treatment (%)			Number of Additional Treatment (%)		
	Vitreous Tap + Antibiotics	PPV + Antibiotics	Dex	Vitreous Tap + Antibiotics	PPV + Antibiotics	Enucleation/ Evisceration
Bleb associated (17)	12 (71)	5 (29)	16 (94)	2 (12)	6 (35)	2 (12)
Post-intravitreal injection (16)	16 (100)	0 (0)	15 (94)	7 (44)	10 (63)	7 (44)
Post-cataract Sx (13)	10 (77)	3 (23)	12 (92)	5 (39)	1 (8)	2 (15)
Post-PKP/K-Pro Sx[a] (8)	5 (63)	3 (37)	8 (100)	4 (50)	2 (25)	1 (13)
Ruptured globe (4)	2 (50)	2 (50)	3 (75)	0 (0)	1 (25)	1 (25)
Miscellaneous[b] (3)	2 (67)	1 (33)	2 (67)	0 (0)	0 (0)	2 (67)
Endogenous (2)	2 (100)	0 (0)	0 (0)	0 (0)	0 (0)	1 (50)
TOTALS (63)	**49 (78)**	**14 (22)**	**56 (89)**	**18 (29)**	**20 (32)**	**16 (25)**

Legend: Dex = dexamethasone, PKP = penetrating keratoplasty, PPV = pars plana vitrectomy, No. = number, K-Pro = keratoprosthesis.

[a] Includes 6 PKP and 2 K-Pro patients,

[b] Miscellaneous group includes two postoperative glaucoma drainage device patients and one perforated corneal ulcer patient.

Am J Ophthalmol. Author manuscript; available in PMC 2015 April 01.

Table 3

Endophthalmitis caused by Streptococcus species: Antibiotic susceptibility patterns and inhibitory concentrations.

***Streptococcus* Organism**	**Number of isolates susceptible to antibiotic/ Number of isolates tested (%)**		
	Vancomycin	**Ceftriaxone**	**Levofloxacin**
β-hemolytic Streptococci	5/5 (100)	3/3 (100)	5/5 (100)
Streptococcus pneumoniae	13/13 (100)	9/10 (90)	13/13 (100)
Streptococcus viridans group	42/45 (93)	38/38 (100)	39/43 (91)
TOTALS	**60/63 (95)**	**50/51 (98)**	**57/61 (93)**
	MIC (μg/ml) of antibiotic required to inhibit 90% of streptococcal isolates (range)		
Time Period	**Vancomycin**	**Ceftriaxone**	**Levofloxacin**
2000 – 2005	1 (0.25 – 1.0)	0.5 (0.012 – 0.60)	1.5 (0.38 – 2.0)
2006 – 2011	1 (0.38 – 1.5)	0.75 (0.016 – 1.5)	3 (0.25 – 32)

Legend: MIC = minimal inhibitory concentration, n = number of isolates tested.

Table 4

Endophthalmitis caused by *Streptococcus* species: Summary of presenting and visual acuity outcomes for the different clinical presentation and *Streptococcus* isolates.

Clinical Scenario (No.)	Presenting VA		VA outcomes			
	Mean LogMAR VA +/−SD	Mean Snellen VA equivalent	No. of patients (%)		Mean LogMAR VA +/−SD	Mean Snellen VA equivalent
			≥20/400	<20/400		
Bleb associated (17)	2.18 +/− 0.27	20/3,000	8 (47)	9 (53)	1.74 +/− 0.97	20/1,100
Post-intravitreal injection (16)	2.44 +/− 0.49	20/5,500	1 (6)	15 (94)	2.54 +/− 0.79	20/6,900
Post-cataract Sx (13)	2.43 +/− 0.27	20/5,400	4 (30)	9 (70)	1.94 +/− 1.17	20/1,700
Post-PKP/K-Pro Sx[a] (8)	2.54 +/− 0.56	20/6,900	2 (25)	6 (75)	2.15 +/− 0.94	20/2,800
Ruptured globe (4)	2.40 +/− 0.20	20/5,000	1 (25)	3 (75)	2.25 +/− 0.76	20/3,600
Miscellaneous[b] (3)	2.70 +/− 0.00	20/10,000	0 (0)	3 (100)	3.00 +/− 0.00	20/20,000
Endogenous (2)	2.50 +/− 0.28	20/6,300	0 (0)	2 (100)	2.85 +/− 0.21	20/14,000
***Streptococcal* Isolates (No.)**						
β-hemolytic *Streptococci* (5)	2.25 +/− 0.66	20/3,600	2 (40)	3 (60)	2.16 +/− 1.19	20/2,900
Streptococcus Pneumoniae (13)	2.22 +/− 0.62	20/3,300	5 (38)	8 (62)	2.04 +/− 1.05	20/2,200
Streptococcus Viridans group (45)	2.45 +/− 0.47	20/5,600	9 (24)	36 (76)	2.20 +/− 0.94	20/3,200
TOTALS (63)	**2.39 +/− 0.51**	**20/4,900**	**16 (25)**	**47 (75)**	**2.16 +/− 0.97**	**20/2,900**

Legend: K-Pro = keratoprosthesis, logMAR = logarithm of minimal angle of resolution, No. = number, PKP = penetrating keratoplasty, SD = standard deviation, VA = visual acuity.

[a] Includes 6 PKP and 2 K-Pro patients,

[b] Includes two post-operative glaucoma drainage device patients and one perforated corneal ulcer patient.

Table 5

Comparison of studies of endophthalmitis caused by *Streptococcus* species.

	Current Study 1/2000 – 12/2011	Mao Study 1/1977 – 5/1990	
Clinical Scenario	**Number of Patients (%)**	**Number of Patients (%)**	**P-value[d]**
Bleb associated	17 (27)	8 (17)	0.253
Post-intravitreal injection	16 (25)	0 (0)	**0.000**
Post-cataract Sx	13 (21)	30 (63)	**0.000**
Post-PKP/K-pro Sx[a]	8 (13)	2 (4)	0.182
Ruptured globe	4 (6)	6 (13)	0.324
Miscellaneous[b]	3 (5)	2 (4)	1.000
Endogenous	2 (3)	0 (0)	0.505
Initial Management			
Vitreous Tap + Antibiotics	49 (78)	16 (33)	**0.000**
PPV + Antibiotics	14 (22)	32 (67)	**0.000**
Intravitreal Corticosteroids	56 (89)	8 (17)	**0.000**
Streptococcal Isolate			
β-Hemolytic *Streptococci*	5 (8)	5 (10)	0.743
Streptococcus Pneumoniae	13 (21)	6 (13)	0.315
Streptococcus Viridans group	45 (71)	24 (50)	**0.000[e]**
Enterococcus	Not Included	13 (27)	n/a
Antibiotic Susceptibility			
Vancomycin	60/63 (95)	46/46 (100)	0.365
Ceftriaxone	50/51 (98)	35/46 (80)[c]	**0.006[f]**
Levofloxacin	57/61 (93)	Not Tested	n/a
Visual Acuity Outcomes			
≥ 20/400	16 (25)	15 (31)	0.528
< 20/400	47 (75)	33 (69)	0.528
Evisceration/Enucleation	16 (25)	1 (2)	**0.000**
TOTALS	**63 (100)**	**48 (100)**	

Legend: K-Pro = keratoprosthesis, PKP = penetrating keratoplasty, PPV = pars plana vitrectomy, n/a = not applicable, Sx = surgery.

[a] Includes 6 PKP and 2 K-Pro patients,

[b] Includes two post-operative glaucoma drainage device and one perforated corneal ulcer patient,

[c] All non-susceptible isolates were *Enteroccous* species,

[d] Fisher's Exact Test,

[e] When excluding Enterococcus, p = 0.819,

[f] When excluding Enterococcus, p = 0.411.