Incidence of post-cataract endophthalmitis at Aravind Eye Hospital

Outcomes of more than 42 000 consecutive cases using standardized sterilization and prophylaxis protocols

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PURPOSE: To report the incidence of postoperative endophthalmitis at a high-volume eye hospital in southern India using a modified cost-effective sterilization protocol.

SETTING: Aravind Eye Hospital and Post Graduate Institute of Ophthalmology, Pondicherry, India.

METHODS: In this retrospective observational series at a single eye hospital, records of patients who had cataract surgery using a modified sterilization protocol from January 2007 through August 2008 and developed postoperative endophthalmitis within the first 3 postoperative months were drawn from a computerized database. The patient's socioeconomic status, the surgeon's experience, and the type of cataract procedure performed were analyzed as possible risk factors using the chi-square test/Fischer exact test.

RESULTS: During the study period, 42 426 cataract surgeries were performed. From these, 38 cases of presumed postoperative endophthalmitis were identified (incidence 0.09%). Thirty-five of the 38 cases were in the manual large- and small-incision extracapsular cataract extraction (ECCE) group, which had a statistically higher rate than the phacoemulsification group ($P = .016$). There was no statistical difference in the endophthalmitis rates between private patients and charity patients for either surgical method (manual ECCE or phacoemulsification).

CONCLUSIONS: The modified sterilization and asepsis protocol adopted to facilitate high-volume cataract surgery in a clinical setting appeared to be safe and effective in preventing postsurgical endophthalmitis. Despite a 3:1 ratio of manual ECCE to phacoemulsification and the elimination of certain traditional sterilization practices, the rate of endophthalmitis in this generally underserved patient population with multiple risk factors for infection was comparable to that reported in other modern settings.

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Cataract extraction is by far the most common intraocular surgery performed worldwide. It is estimated that in India alone, more than 5.1 million patients have cataract surgery annually.[1] Postoperative endophthalmitis is a rare but dreaded complication of cataract surgery, with a reported incidence currently in the range of 0.04% to 0.41%.[2,3] In most cases, this complication is unforeseeable, its progression is unpredictable, and the visual outcome can be devastating. With a projected steep rise in the already sizable global volume of cataract surgery, minimizing the rate of endophthalmitis and the cost of performing surgery will be extremely important.[4,5]

Cataract surgeons must continue to perform surgeries in a sterile, efficient operating room with proper aseptic techniques. However, many longstanding accepted aseptic recommendations, such as changing gowns and gloves and using the longest autoclave cycles, arose in surgical specialties outside ophthalmology. Although some practices add significantly to the cost of providing surgery, their benefit to cataract patients has not been proven. Cataract surgery is already a major societal economic burden in developed and developing countries.[6–8] Therefore, to keep cataract surgery safe, cost effective, and affordable on a global scale, it is important to measure outcomes

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and to periodically review and revise operating protocols based on the best available evidence.

The Aravind Eye Care System (AECS) is a network of 5 regional eye hospitals that provide high-level ophthalmic care to the underprivileged population of southern India. Of the approximately 180000 cataract procedures performed annually, about 30% are performed on private, paying patients. This revenue also funds the remaining 70% of the cataract surgeries, which are provided at little or no cost to the individual.[9] On average, physicians in our network of hospitals collectively perform more than 800 intraocular surgeries per day. To facilitate and support this high volume, we have developed an operating room protocol to ensure sterility and efficient turnover of cases for all intraocular procedures (R.D. Ravindran, MD, et al., "The Necessary Steps for Endophthalmitis Prophylaxis," Cataract & Refractive Surgery Today, April 2007, pages 106–108. Available at: http://www.crstoday.com/PDF%20Articles/0407/CRST0407_17.php. Accessed January 15, 2009).

The same protocol is used at all 5 AECS hospitals. The protocol was designed to address all potential sources of nosocomial infection and to be cost effective at the same time. Based on stringent monitoring of our outcomes and the continuous improvement process, we have found this protocol to be efficient and effective at minimizing postoperative infection. This study reports the incidence of postoperative endophthalmitis in all patients who had cataract surgery at a single regional AECS hospital (Pondicherry Hospital) during a 20-month period from January 2007 through August 2008. It also outlines the standard aseptic protocol for high-volume cataract surgery being followed in our hospital system.

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PATIENTS AND METHODS

A retrospective analysis of the case records of 42426 eyes of all patients who had cataract surgery at Aravind Eye Hospital, Pondicherry, during the study period was performed. All procedures were performed using 1 of 3 surgical methods: phacoemulsification, large-incision extracapsular cataract extraction (ECCE), or manual small-incision cataract surgery (manual SICS).[10] Manual small-incision cataract surgery is a modified form of ECCE performed through a 6.5 to 7.0 mm sclerocorneal tunnel. The procedure is performed using a can-opener capsulotomy or capsulorhexis depending on the experience level of the surgeon and the cataract density. The nucleus is prolapsed from the bag using a Sinskey hook or a hydrodissection injection. The prolapsed nucleus is then removed using an irrigating vectis attached to a 5.0 cc syringe. After intraocular lens (IOL) implantation, the chamber is pressurized and the wound is left unsutured in most cases.

The experience level of the surgeon, socioeconomic status of the patient, method of surgery, and any microbiological testing results were recorded. Based on their level of clinical and surgical experience, the operating surgeons were classified as full-time staff (FTS) or surgeons-in-training (SIT). A subanalysis of the latter group's data was performed, depending on whether the surgeon was a resident, fellow, or mini-fellowship trainee. The latter was a practicing ophthalmologist who was enrolled in a short-term surgical training program of 4 to 8 weeks duration. The FTS had a minimum of 3 years of post-residency experience. A subanalysis of this group's data was performed, depending on whether the surgeon was a senior or junior staff member (minimum of 5 years versus 3 years of experience).

Socioeconomically, patients were placed in 1 of 2 groups based on their ability to pay for their care. Private patients consisted of those who paid the regular private surgical fee. Charity patients were primarily identified through outreach screening camps and were transported from a rural screening location to the hospital for surgery. The rural charity patients did not have to pay for their surgery, postoperative care, or hospital stay. Approximately one fourth of the charity group consisted of local patients who paid a deeply discounted fee that covered the cost of consumable supplies such as the IOL. The private patients were operated on by the FTS and could choose the cataract surgical method, with the majority selecting phacoemulsification. All members of the medical staff performed surgery on the charity patients, who had phacoemulsification, manual SICS, or ECCE as determined by the operating surgeon. Charity patients rarely receive phacoemulsification because of the higher associated costs.

Endophthalmitis was diagnosed based on the examining ophthalmologist's clinical judgment during the normal course of postoperative care lasting up to 3 months after surgery. When endophthalmitis was suspected, a vitreous biopsy was immediately performed and sent to the hospital's microbiology laboratory for culture and sensitivity testing. Coincident with the vitreous tap, intravitreal antibiotics were administered without waiting for the laboratory and culture results. In addition to Gram stain microscopy, the vitreous specimen was inoculated directly onto blood agar, chocolate agar, Sabouraud agar, and thioglycolate broth for culture. A positive culture was defined as growth of the same organism in 2 or more media or confluent growth on 1 solid medium. Growth in thioglycolate broth alone or scant growth on 1 solid medium was considered equivocal. Surgical complications,

such as posterior capsule tear or vitreous loss, were recorded on the patients' operative data sheets.

Because of transportation constraints, most of the cataract patients were admitted to the hospital for an overnight stay. Some were discharged after the 1-day postoperative examination, while underprivileged patients from the outreach camps stayed for 3 days as a routine. At the time of discharge, all patients received detailed verbal instructions from trained staff regarding topical medications and postoperative precautions. The patients were instructed to use ciprofloxacin 0.3% eyedrops 4 times a day for 7 days and a topical combination antibiotic–corticosteroid solution (dexamethasone 0.1% combined with either ciprofloxacin 0.3% or chloramphenicol 0.5%) in tapering dosages during a 45-day postoperative period. Subsequent follow-up examinations were scheduled at 1 month and 3 months. During these follow-up visits to the hospital or to a regional camp, a refraction and comprehensive ophthalmic evaluation was performed.

During the study period, private patients had a follow-up rate of 94%, while charity patients had a follow-up rate of 84%. Because the hospital is one of the largest tertiary-care centers providing vitreoretinal services in the region and because it is available to any patient with postoperative complications, it is unlikely that any patient would have developed endophthalmitis and not been seen by one of the hospital's physicians. The incidence of postoperative endophthalmitis among the patient and surgeon groups was analyzed and compared. The chi-square test/Fischer exact test was used for the comparison of categorical variables. Stata software (version 8.0, StataCorp LP) was used for statistical analysis. A P value less than 0.05 was considered statistically significant.

The standard sterilization and antisepsis protocol used at all AECS operating rooms is as follows: On the day before surgery, the surgical instruments and the required linen are packaged in surgical drums and are sterilized using long cycles with a conventional pressure-type sterilizer (Nat Steel Equipment). The instruments are exposed to a temperature of 120°C at 20 psi for 45 minutes. The entire cycle takes 2 hours with the additional 75 minutes required for building up the temperature and vacuum pressure and later exhausting the steam and drying the instruments. The instruments required for 1 procedure are placed in a small stainless steel tray, which is wrapped loosely with a cotton towel. Eight wrapped instrument trays, along with other required additional instruments, are placed inside a large surgical drum. Commercially produced lactated Ringer's intravenous solutions are used for irrigation. Because these solutions are not specifically prepared for eye surgery and because of the lack of adequate sterility measures, the irrigating fluid bottles are also routinely autoclaved on the day before surgery as an additional precaution. The bottles are also visually inspected for suspended particles before autoclaving and before they are used in the operating room.

Preoperative infection prophylaxis consists of applying topical conjunctival antibiotic agents and ensuring the patency of the patient's nasolacrimal duct. A preoperative conjunctival culture is performed if the patient has functional vision in only 1 eye, has partial or complete blockage of the nasolacrimal passage, or has received recent treatment for an infected eyelid. Because chronic dacryocystitis is common in the hospital's cataract patient population, the nasolacrimal passage is routinely irrigated to rule out an obstruction and associated infection. If necessary, a dacryocystectomy is performed before cataract surgery. Cataract surgery is also postponed if an active infection of the eyelid margin or conjunctiva is present. On the day before surgery, povidone–iodine 10% is used to clean the eyelids and periocular skin and patients receive ciprofloxacin 0.3% eyedrops 6 to 8 times in the operative eye. Systemic antibiotic agents are not used. On the day of surgery, patients continue to receive topical ciprofloxacin. They do not wear hospital gowns and enter the operating room wearing their own clothes. Their feet and head are covered with clean protective booties and a cap, respectively. In the preoperative holding area, the periocular skin is cleansed with povidone–iodine 10% solution and a regional anesthetic block is administered. The unsedated patients walk from the holding area into the operating room, where they climb onto the operating table. Once the patients are on the operating table, the periocular cleansing with povidone–iodine is repeated and a drop of povidone–iodine 5% solution is instilled onto the ocular surface. Antibiotics are not placed in the irrigating solutions, nor are they injected subconjunctivally or intracamerally.

The separate instrument trolley (a Mayo stand on wheels) is lined with sterile cotton towels, which in turn are covered with sterile plastic sheets to prevent the transfer of lint and to avoid wetting the sheets. The sterilized instrument tray is transferred from the larger sterile surgical drum and placed on the instrument trolley by the scrub nurse. The staff then places instruments from the instrument tray over a folded plastic sheet, ensuring that the tips do not touch the trolley's surface. The empty tray remains in the corner of the trolley (Figure 1). After surgery, the used instruments are placed back in the tray and then handed to the circulating nurse for short-cycle steam sterilization.

To maximize operative productivity and minimize turnover time, a single surgeon alternates between 2 adjacent operating tables. As 1 patient is having cataract surgery, the next patient's eye is cleaned and prepared on the second operating table by a circulating nurse (Figure 2). At the same time, the second scrub nurse prepares and arranges the instruments for the next surgery from a fresh sterile tray. The surgeon operates with 1 floor-mounted operating microscope, which can be swung from 1 operating table to the other for each successive surgery. Each scrub nurse prepares the patient for surgery by draping the eye, inserting the eyelid speculum, and placing the superior rectus traction suture in cases of ECCE and manual SICS. The circulating nurse hands disposable supplies to the scrub nurse, reads the preoperative details to the operating surgeon, completes the written nursing record, and bandages the operated eye at the conclusion of surgery. Each surgeon is provided with 3 to 4 instrument sets per operating table; the sets are rotated throughout the day.

At the completion of surgery, 1 drop of povidone–iodine 10% solution and 1 drop of topical homatropine are instilled before the eye is bandaged. Between patients, the surgical staff members rinse their gloved hands with antiseptic solution containing chlorhexidine 0.5% and isopropyl alcohol 70% (Aurorub). Neither the gloves nor the gowns are changed until the surgeon has performed 10 surgeries or more.

To sustain a high volume of surgery, a high-speed sterilizer (Nat Steel Equipment) is used for short-cycle steam sterilization of the surgical instruments between cases. At

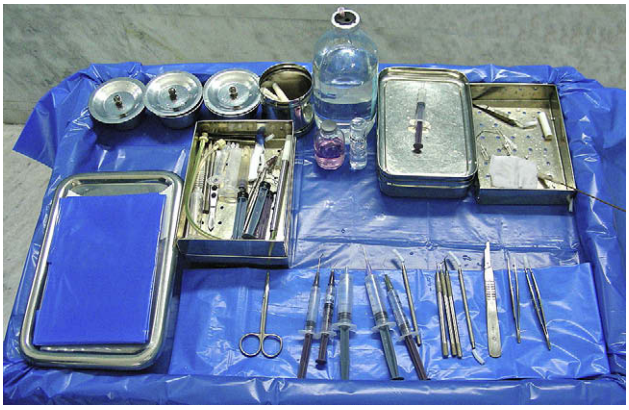

Figure 1. Instrument trolley with a set of surgical instruments and the tray instruments.

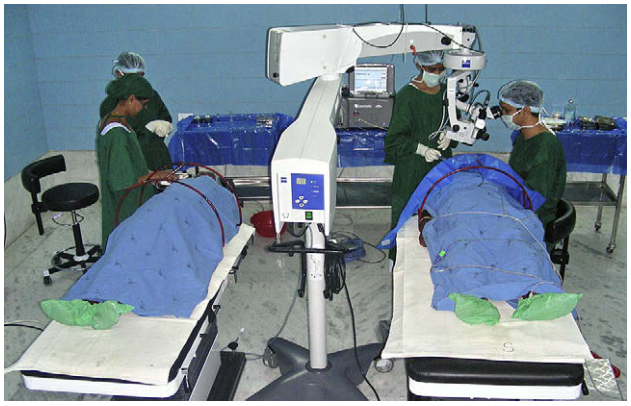

Figure 2. The operating room setup showing 2 adjacent operating tables with an operating microscope between.

the conclusion of each operation, used instrument trays are sent to a centralized area within the operating room complex for cleaning with deionized water and sterilization. Up to 8 separate unwrapped instrument trays are placed in a single surgical drum for short-cycle steam sterilization (Figure 3). The chamber of the autoclave can accommodate 2 such surgical drums, each containing 8 instrument sets. The instruments are sterilized for a 17-minute total cycle, during which time they are exposed to a temperature of 134°C and 30 pounds of pressure for 10 minutes. The remaining 7 minutes are needed for temperature and pressure buildup and rapid exhaust and vacuum drying of the instruments. The sterilized surgical drums are then returned to each operating room, where the scrub nurse will take out individual sterile instrument trays for subsequent surgeries. As the full rapid autoclave cycle is approximately 17 minutes long, 50 to 60 instrument sets can be effectively turned over in 1 hour and an uninterrupted supply of instruments for continuous surgery can be maintained. The ultrasonic handpiece is not sterilized between phacoemulsification cases; however, the phaco needles, sleeves, and irrigation/aspiration (I/A) handpieces are sterilized. Similarly, for manual SICS, the Simcoe I/A cannula tip is sterilized but the I/A tubing is not. In addition to the main I/A tubing, the bottle of irrigation fluid and the small bottle of Ringer's lactate solution on the trolley (used to wet and irrigate the eye) are reused from 1 case to the next.

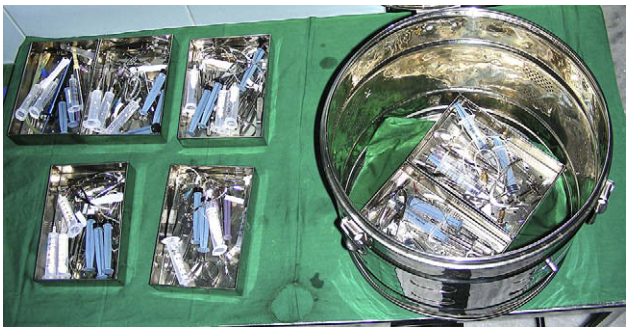

Figure 3. The surgical drum with multiple instrument sets ready for short-cycle sterilization.

RESULTS

Between January 2007 and August 2008, 42426 cataract surgeries were performed. Thirty-eight cases (0.09%) were diagnosed with presumed infectious postoperative endophthalmitis. Table 1 shows the distribution of types of procedures done and the incidence of endophthalmitis. The highest incidence of endophthalmitis cases occurred in the manual SICS group. The incidence in the manual SICS group + ECCE group was statistically significantly higher than the incidence in the phacoemulsification group (unadjusted odds ratio = 3.8 (1.2, 19.4); $P = .016$).

Table 1 also compares the endophthalmitis rates between different surgeon categories based on level of experience. For phacoemulsification, the endophthalmitis rate was statistically significantly higher in the SIT group than in the FTS group ($P = .002$). However, for manual SICS and ECCE procedures, the endophthalmitis rates were the same between the SIT group and the FTS group. Eight (61.5%) of the 14 cases of endophthalmitis attributed to the residents, fellows, and trainees occurred during the first 3 months of their learning a new procedure. In the data subanalysis, there were no statistically significant differences in endophthalmitis rates between residents, fellows, and minifellowship trainees or between senior and junior FTS.

Table 2 shows the distribution of endophthalmitis according to the patient's socioeconomic background. Phacoemulsification was performed in 4% (1304/30404) of charity patients and 76% (9163/12022) of private patients. The endophthalmitis rate between charity patients and private patients was not statistically significantly different for phacoemulsification ($P = .329$) or for manual SICS+ECCE ($P = .367$). Endophthalmitis was diagnosed in 17 cases (46%) during the immediate (1 week) postoperative period; all were charity patients. Between 2 and 6 weeks, an additional 18 cases of endophthalmitis were diagnosed. Three

Table 1. Distribution of endophthalmitis according to type of surgery and surgeon experience.

	Full-Time Staff		Surgeons in Training		Total	
Surgery Type	Patients, n	Endophthalmitis Cases, n (%)	Patients, n	Endophthalmitis Cases, n (%)	Patients, n	Endophthalmitis Cases, n (%)
Phaco	10167	2 (0.02)	300	1 (0.33)	10467	3 (0.03)
Manual SICS	21284	22 (0.10)	8086	12 (0.15)	29370	34 (0.12)
Manual ECCE	12	0	2577	1 (0.04)	2589	1 (0.04)
Total	31463	24 (0.08)	10963	14 (0.13)	42426	38 (0.09)

ECCE = large-incision extracapsular cataract extraction; SICS = small-incision cataract surgery

cases were diagnosed more than 6 weeks after surgery (Table 3).

Preoperative risk factors for developing endophthalmitis were identified from the case records. Eight patients (21.6%) were diabetic, and 5 patients (13.5%) had a blocked nasolacrimal duct with regurgitation of clear fluid on irrigation with a syringe. On subsequent reirrigation in these cases after the onset of endophthalmitis, 1 patient had purulent regurgitation, which may have been the cause of the infectious endophthalmitis. The vitreous tap in this patient grew *Streptococcus pyogenes* that was probably not related to the sterilization process. He subsequently had a dacryocystectomy. In the only endophthalmitis patient who had ECCE, the infection was diagnosed after a wound leak was resutured. Five cases (13.5%) of endophthalmitis occurred in eyes that had a posterior capsule rupture and vitreous loss, which are well-recognized risk factors for infection.

Eleven vitreous samples (29%) were culture positive, and all had sutureless manual SICS. The remaining 27 cases (71%) with a clinical diagnosis of endophthalmitis had phacoemulsification, manual SICS, or ECCE and were culture negative. The final visual acuity was 6/60 or better in 29 patients (76.3%) after a mean follow-up of 8 weeks (Table 4). Twenty-three patients (62%) gained at least 3 lines on the Snellen chart and 19 (51.3%) gained 6 lines or more after treatment of the endophthalmitis. Ten of the 14 eyes that required vitrectomy had an improvement of at least 3 lines of Snellen acuity. No endophthalmitis patient who had vitrectomy had a decrease in visual acuity. Four eyes (10.8%) went blind to a level of no light perception. Three of these eyes developed phthisis bulbi; the fourth had to be eviscerated due to corneal melting with perforation. Of the 42426 total consecutive eyes in this study, 9 (0.02%) ended with an acuity with 6/60 or worse in association with a diagnosis of infectious endophthalmitis. The odds of legal blindness due to postsurgical endophthalmitis were therefore 1 in 4700.

DISCUSSION

In our high-volume clinical setting, where we perform more than 100 intraocular surgeries per day, there is a significant risk for cluster endophthalmitis if proper asepsis is compromised.[11,12] More than 50% of our patients came from poor rural areas, where risk factors such as poor personal hygiene, malnutrition, poor sanitation, and lack of access to clean water are prevalent. Most of these patients had advanced cataracts requiring larger incisions and longer surgical times. In addition, a significant number of our cases were performed by ophthalmologists engaged in surgical training. This includes more than 30 residents and fellows as well as many practicing ophthalmologists who come to our hospital for supplemental cataract surgery training.

Table 2. Distribution of endophthalmitis according to type of surgery and patient socioeconomic status.

	Private		Charitable		Total	
Surgery Type	Patients, n	Endophthalmitis Cases, n (%)	Patients, n	Endophthalmitis Cases, n (%)	Patients, n	Endophthalmitis Cases, n (%)
Phaco	9163	2 (0.02)	1304	1 (0.08)	10467	3 (0.03)
Manual SICS	2855	1 (0.04)	26515	33 (0.12)	29370	34 (0.12)
Manual ECCE	4	0	2585	1 (0.04)	2589	1 (0.04)
Total	12022	3 (0.02)	30404	35 (0.12)	42426	38 (0.09)

ECCE = large-incision extracapsular cataract extraction; SICS = small-incision cataract surgery

Table 3. Time of endophthalmitis diagnosis classified according to surgical method and patient socioeconomic status.

	Immediate (Within 1 Week)		Delayed (From 2 Weeks to 3 Months)		
Type of Surgery	Private	Charitable	Private	Charitable	Total
Phaco	0	0	2	1	3
Manual SICS	0	16	1	17	34
Manual ECCE	0	1	0	0	1

ECCE = large-incision extracapsular cataract extraction; SICS = small-incision cataract surgery

Table 4. Final visual outcome classified according to culture results.

Acuity	Culture Positive	Culture Negative	Total
6/18–6/6	2	13	15
6/60–6/24	5	9	14
1/60–5/60	0	3	3
<1/60	1	1	2
No PL	3	1	4
Total	11	27	38

No PL = no light perception

Despite these circumstances, we have been able to achieve an acceptably low institutional rate of infectious endophthalmitis by using the standardized infection prophylaxis protocols described in this paper. The use of high-speed short-cycle steam sterilization and continuous reuse of I/A tubing and irrigating solutions have enabled us to perform high-volume, efficient, and cost-effective cataract surgery with an endophthalmitis rate of 0.09%, which is comparable to that reported in developed countries.[13,14] Medicare data from the 8-year 1994 to 2001 period showed a 0.21% incidence of postoperative endophthalmitis,[15] and a review of the ophthalmic literature for the 2000 to 2003 period showed an incidence of 0.26%,[16] which is higher than in previous decades.

The prospective multicenter multinational ESCRS study of endophthalmitis prophylaxis[17] reports an overall endophthalmitis incidence of 0.17% (29 of 16603 patients). Although we used only topical fluoroquinolones without intracameral or subconjunctival antibiotic agents, our overall 0.09% incidence of presumed infectious endophthalmitis was comparable to that in the ESCRS subgroup receiving intracameral antibiotics (0.075%) and much lower than in the ESCRS control subgroup using only topical antibiotic agents (0.25%). The incidence of culture-positive endophthalmitis in our study population was only 29%.

Consistent with a previously published study from a different Aravind hospital,[18] the most common organism was *Nocardia*. It is possible that some of our culture-negative cases of suspected endophthalmitis were not infectious but rather were cases of toxic anterior segment syndrome.[19–21]

The incidence of endophthalmitis was statistically significantly higher after sutureless manual SICS than after phacoemulsification in both surgeon groups in the present study. Similarly, Kalpadakis et al.[22] found a much higher incidence of endophthalmitis after large-incision ECCE (1.13%) than after phacoemulsification (0.57%) in a socioeconomically poor community in Greece. Although none of our infected patients had clinical evidence of a wound leak, a larger sutureless incision may create the potential for momentary wound incompetence. The higher overall rate of endophthalmitis in the charity patient group is consistent with the majority who received manual SICS.

In our study, the incidence of endophthalmitis in patients who had phacoemulsification was only 0.02%. These were predominantly private patients (88%), and this is comparable to recently reported rates with phacoemulsification from the United States and Europe, which range from 0.04% to 0.07%.[2,23,24] The ESCRS study[17] of endophthalmitis prophylaxis reports an incidence of 0.05% after phacoemulsification in patients receiving a combination of topical and intracameral antibiotic prophylaxis. We found a higher overall rate of endophthalmitis in surgeries performed by SIT, such as residents, fellows, and mini-fellowship trainees (0.13%), than in surgeries performed by FTS (0.08%); this may simply reflect the more common use of phacoemulsification by the latter group. However, that 60% of the SIT endophthalmitis cases arose during the surgeon's first 3 months of training suggests that surgeon inexperience was a contributing risk factor.[25–27]

In our experience, obstructed nasolacrimal passages and conjunctival microbial colonization are among the most common causes of postsurgical infection after cataract surgery in our patient population.[28] Our operating room protocols, therefore, strive to adequately sterilize the conjunctival surface before surgery. The operating rooms are air conditioned and positively pressurized with 15 air changes per hour passing through HEPA filters. We also adhere to procedures that ensure clean and sterile surgical instruments for each case. However, we have eliminated other widely practiced measures that we believe add unnecessarily to the cost of surgery. For example, evidence generated from our hospitals suggests that changing surgical gloves and gowns after each case does not reduce the risk for infection.[29] Because the ocular surface is sterile and the surgical staff's gloved fingers do not contact blood or the instrument tips (no-touch

technique), we believe that rinsing surgical gloves with antiseptic solution between cases is sufficient to maintain their sterility. To maximize the productivity of the cataract surgeon, we simultaneously prepare the next patient while another is having surgery on an adjacent operating table. Finally, to enable the rapid turnover of patients, we use short-cycle steam sterilization without wrapping the surgical instruments.

In many countries, sterilization and aseptic protocols for ophthalmic surgery have been arbitrarily devised by regulatory agencies. Many of these measures originated from work performed outside ophthalmology and may not be necessary for our specialty. Because of the increasing need for cataract surgery to be both safe and cost effective, it is important to periodically reevaluate potentially unnecessary practices based on carefully monitored studies of surgical outcomes. Based on continuous monitoring of outcomes data, we have concluded that our efficient and cost-effective system, which includes short-cycle steam sterilization and continuous reuse of gowns, gloves, surgical tubing, and solutions, is safe.

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