School of Pharmacy

Chemoprophylaxis for the prevention of endophthalmitis after Cataract surgery- Patterns of use and economic costs.

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This thesis is presented for the degree of
Master of Pharmacy
of
Curtin University of Technology

February 2006

DECLARATION

This Thesis contains no material which has been accepted for the award of any other degree or diploma in any other University or institute.

To best of my knowledge and belief this thesis contain no material previously published by any other person except where due acknowledgement has been given.

Deepinder Singh Rosha

Dated:

ACKNOWLEDGEMENT

It is my cherished privilege to acknowledge my debt and express my sincere gratitude to all those who have helped me accomplish this humble venture.

Words alone in no way shall amply articulate my deepest gratitude; valuation and indebtedness for my revered supervisors ***Prof. Bruce Sunderland*** and ***Mrs. Delia Hendrie*** who has been a perpetual source of guidance and unflinching support. Their keen supervision, invaluable suggestions, illuminated vision and persistent encouragement have made this project possible today.

I am complaisantly beholden to my co-supervisor ***Dr. Jonathon Ng*** for his invaluable advices and kind cooperation extended to me during my project work.

I felicitously mark off the enlightening guidance and concrete suggestions rendered gladsomely by ***Dr. Nigel Morlet***, consultant ophthalmologist, Royal Perth Hospital, in carrying this work through to completion.

It behoves me to acknowledge the help of all faculty members and administrative staff of School of Pharmacy especially ***Prof. Michael Garlepp***, Head of school, ***Mrs. Daphne D'Souza***, and ***Mr. John Hess*** for their active support.

I am deeply grateful to ***Dr. Frank Sanfilippo***, Research Fellow, School of population health, University of Western Australia, for his manifold help.

I owe a grateful acknowledgement of gratitude to ***Mr. Cambell Metcalfe***, Clinical Business Analyst, SCGH, ***Mr. Paul Bronson*** Cost Accountant, South Metropolitan Health Service, **Mr. Ross Barrett**, Fremantle Hospital, ***Mr. Howard Andre*** and ***Mr. Rinaldo Ienco***, Finance office, Royal Perth Hospital for providing me with valuable cost information about the management of endophthalmitis.

Words of earnest thanks to ***Mrs. Jennifer Benzie***, chief pharmacist Sir Charles Graindner Hospital, ***Mr. Sean Lewis*** dispensing services coordinator, Royal Perth

Hospital, ***Mr. Richard Donnelly,*** deputy chief pharmacist, Fremantle Hospital for their timely help and cooperation extended to materialize this project work.

Special word of thanks for ***Mr. Satinder Dhaliwal*** and ***Mrs. Kiranpreet Dhailwal***, for providing me valuable help and sagacious guidance at all times.

Mere words cannot acknowledge my intense feelings of gratitude towards my treasured friends ***Jagpreet*** and ***Jeevan*** for their supportive attitude and ever available help. I am indeed thankful to all my friends in Perth for making this time memorable, with lots of sweet reminiscences to look back at.

Transcending all this, the unbounded affection, constant inspiration and blessings of my ***parents*** cannot be expressed by mere words. With a deep sense of reverence, I acknowledge my parents for their unconditional support and ever encouraging attitude. I owe a special word of thanks towards my younger brother ***Maninder***, for his cheerfulness and encouragement. My final debt is to all dear ones whose unruffled patience, silent encouragement and exhilarative paen to see me work has eventuated in this denouement.

Above all, I bow my head before the Almighty God with whose grace and beatitude, I moved through this venture.

ABSTRACT

Objectives

The objectives of study were to (i) examine the regional differences in methods of performing cataract surgery across different jurisdictions in Australia and New Zealand (ii) identify risk factors for post-operative endophthalmitis and (iii) explore the implication of changes in surgical practice on the number of cases of post-operative endophthalmitis and resultant net cost to health system.

Methods

Cataract surgeons across Australia and New Zealand were surveyed about their demographics, surgical techniques, use of pre- and post-operative antibiotics and antiseptics and cases of post-operative endophthalmitis. Statistical analysis was conducted to determine the regional variations in the use of methods of chemoprophylaxis and surgical practices. Multivariate Poisson regression was performed to identify factors associated with the incidence of post-operative endophthalmitis. A cost analysis was conducted to determine the impact of an increased use of chemoprophylatic treatment on the number of cases of post-operative endophthalmitis and net cost savings to the health system from its use. In addition, the results of the current survey of surgical practices of cataract surgeons was compared with those from an earlier survey conducted approximately 10 years ago.

Result

The response to the survey of ophthalmologists was 82%, but after excluding ophthalmologists who did little or no cataract surgery, the study sample comprised 540 participants of the 896 who were initially sent the survey. Participating cataract surgeons reported 162,120 cataract surgeries and 92 cases of post-operative endophthalmitis, an incidence rate of 0.056%.

Regional variations were found in the methods of chemoprophylaxis and surgical techniques. Chloramphenicol was the most frequently used topical antibiotic in Australia, while neomycin was used by majority of cataract surgeons in New Zealand.

The only notable change found over the past decade was a sharp fall in use of subconjunctival antibiotics from 75% to 45% in the current survey. A slight increase in use of post-operative topical antibiotics was noticed.

Subconjunctival injection of antibiotics was the only form of chemoprophylaxis associated with a reduction in incidence of endophthalmitis. Results from this survey indicated that cataract surgeons routinely using corneal or limbal incisions had an incidence of endophthalmitis considerably higher than those surgeons routinely using scleral wounds, whilst surgeons routinely using temporally sited wounds had almost half the incidence of endophthalmitis compared to surgeons using superior wounds.

The cost implications of subconjunctival gentamycin injection for chemoprophylaxis were examined. Additional costs of subconjunctival antibiotics were subtracted from the reduced cost of treating fewer cases endophthalmitis. There would potentially be a net saving to the Australian health system of \$ 110,354 if all cataract surgeons used subconjunctival chemoprophylaxis.

Conclusion

Regional variation in chemoprophylaxis and surgical techniques did not entirely explain differences in post-operative endophthalmitis incidence. Subconjunctival antibiotics would only need to reduce the incidence of endophthalmitis by 15% for it to be cost-effective.

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ABBERIVATIONS

ACT	Australian Capital Territory
CSR	Cataract Surgery Rate
ECCE	Extra Capsular Cataract Extraction
GA	General Anaesthesia
ICCE	Intra Capsular Cataract Extraction
IOL	Intra Ocular Lens
LOS	Length of Stay
NSW	New South Wales
NT	Northern Territory
NZ	New Zealand
OPD	Out- Patient Department
PCR	Polymerase Chain Reaction
PMMA	Poly methyl meth acrylate
Qld	Queensland
RANZCO	Royal Australia and New Zealand College of Ophthalmology
SA	South Australia
Tas	Tasmania
USA	United States of America
Vic	Victoria
WA	Western Australia
WHO	World Health Organisation

1 INTRODUCTION

1.1 Cataract

Cataract is an ocular condition characterised by opacification of the crystalline lens in the eye which leads to blurring of vision. The natural lens is a crystalline structure composed of water and protein arranged in a precise structure to create a clear passage for light to pass through it, but with ageing, the lens becomes opaque, thus reducing the amount of light reaching the retina.

Cataract is mainly classified into two types[1]:

Senile cataract- Age related cataract, which is the most common type of cataract. Congenital cataract- present at the time of birth due to genetic abnormalities.

Surgery is the only treatment currently available for cataract; this involves removal of the opacified crystalline lens and implanting of an artificial intraocular lens. Cataract surgery has evolved from intracapsular to extracapsular to phacoemulsification in recent years. Phacoemulsification is the predominant method used these days. These advances have lead to faster recovery, improved visual outcome and fewer complications.

1.1.1 Cataract- a global problem

Globally, cataract is the leading cause of blindness. It was estimated to affect 20 million people worldwide and accounted for 47.8% of total blindness in the World in 2002[2].

Cataract surgery is the most widely carried out intraocular intervention around the Australia[3]. With continued increase in the world's aged population the amount of cataract surgery is projected to increase dramatically. Age is the most important risk factor for cataract surgery. Data from the Visual Impairment Project in Australia showed the prevalence of cataract increased significantly after the fifth decade. By the eighth decade half of the population had significant cataract and by the tenth decade everyone was affected by cataract. Taylor *et al*. estimated that cataract was the most common cause for low vision in Australian population and accounted for 37% of visual impairment in 2004[4]. This study also demonstrated an exponential increase in vision loss with increasing age. It was estimated that 1.67 million Australians aged over 50 years were affected by age-related cataract in 2001 and this number is projected to increase to 2.74 million by year 2021. It also reported that 0.32 million people had cataract surgery in 2001, this number has been estimated to increase to 0.52 million in 2021[5]. Around 10,000 cataract procedures are estimated to be carried out in Western Australia per year and this will double in the next 12 years[6] if the past trend continue. The number of cataract surgery increased approximately four-fold in a decade in United States through 1980s[7].In the United Kingdom cataract surgery increased three-fold during same period[8]. Besides the increased in the number of aged population other factors which contribute to increased cataract surgery include indications or visual thresholds for cataract surgery and the proportion of those who need or are eligible for surgery. With the introduction of intraocular lenses which provide excellent rehabilitation in most cases, this has reduced the visual acuity threshold from 6/60 to 6/18 and now 6/9 or less.[9, 10]

The World Health Organisation has defined cataract surgery rate as the number of cataract operations performed per year per million of population. The cataract surgery rate (CSR) for Australia in 1999 was 6300 with 120,000 cataract surgeries performed in a population of 19 million[11]. The cataract surgery rate in the USA was about 5700 and about 4000 for Sweden[11]. WHO reported an estimated CSR in Europe of about 3000, 2000 in India, 500-1500 in Latin America, and generally under 500[1] in Africa. In Western Australia cataract surgery is mainly associated with people aged 60 years or older with those aged 70 years or more providing the greatest increase for surgical treatment[12]

1.1.2 Risk factors for cataract

Age is the single most important risk factor for the occurrence of cataract; other risk factors include: diabetes, penetrating injury to the eye, exposure to ultra violet light, long term use of drugs like systemic or inhaled corticosteroids, use of α- blockers, duration of β-blocker use, duration of aspirin use, duration of hormone replacement therapy, duration of thiazide diuretic use, smoking, heavy drinking and family history of cataracts and low consumption of antioxidants like vitamin C, vitamin E and β-carotene. [1, 13, 14]

1.1.3 Complications of cataract surgery

The major sight threatening complications associated with cataract surgery are postoperative endophthalmitis, dropped nucleus, retinal detachment and corneal decompensation. Post-operative endophthalmitis is the most serious and frequent complication. Although the incidence rate of post-operative endophthalmitis has remained constant, it is anticipated with the increase in the numbers of cataract surgery performed, there will be an increase in the number of cases of post-operative endophthalmitis, unless effectively prevented.

It was anticipated that postoperative endophthalmitis would be reduced with the introduction of small incision phacoemulsification, but the number has remained constant[15, 16]. This can be attributed to a number of factors. These include:

The small incision for phacoemulsification is technically difficult and requires more skills and is constantly changing.

Cataract surgery also involves insertion of an intraocular lens, which could be a potential pathway for the entry of micro-organisms.

In Western Australia the incidence of post operative endophthalmitis remained unchanged during the 12 year of phacoemulsification surgery but the incidence of post operative endophthalmitis decreased by 50% during the transition from intracapsular to extracapsular extraction methods.(2.92 vs. 1.46 cases per 1000 cataract surgeries) but there was no significant reduction in the incidence of postoperative endophthalmitis in the transition from extracapsular to phacoemulsification methods(OR 0.80, 95% CI 0.59-1.09).[17]

1.2 Endophthalmitis

Endophthalmitis is defined as severe intraocular inflammation which may involve both anterior and posterior segments [18, 19].

Endophthalmitis can be categorised into post-operative endophthalmitis, post-traumatic endophthalmitis, endogenous endophthalmitis, or endophthalmitis due to other causes such as sterile uveitis, phacoanaphylactic endophthalmitis etc.

Post-operative endophthalmitis is the most frequently occurring type of endophthalmitis and accounts for more than 70% of cases of endophthalmitis.[20] Post-operative endophthalmitis can occur after any type of intraocular intervention. Post-operative endophthalmitis can further be categorised into acute-onset post-operative endophthalmitis and delayed-onset or chronic postoperative endophthalmitis [21].Acute-onset endophthalmitis occurs within six weeks of intraocular surgery. Clinical symptoms include decreased visual acuity, afferent pupillary defect, hypopyon, corneal oedema, corneal filtrate, fibrinoid anterior chamber response, vitreous inflammation, and retinitis. Pain is common but can be absent. Commonly involved micro-organisms include coagulase-negative staphylococci, *Staphylococcus aureus*, streptococcus species and gram-negative organisms. Delayed-onset or chronic endophthalmitis on the other hand, may present more than six weeks after cataract surgery. It presents with mild to moderate inflammation and a chronic indolent course. The main organism responsible is the gram-positive, anaerobic pleomorphic rod *Propionibacterium acnes*. Clinically, symptoms of chronic postoperative endophthalmitis are similar to those of acute postoperative endophthalmitis. Low grade uveitis may be present; a small hypopyon may also be present.

Post-traumatic endophthalmitis is inflammation of the eye after an eye injury. It has poorer visual outcomes, which could be attributed to injury or different types of micro-organisms. Risk factors for post-traumatic endophthalmitis include lens disruption, presence of an intraocular foreign body, plant or soil related injury, injury in a rural environment, delayed primary repair and penetration with a contaminated device[19]. *Staphylococcus epidermidis* is the most common pathogen, but *Bacillus cereus* is the most aggressive pathogen and is the most commonly cultured micro-organism[19]. *Bacillus cereus* endophthalmitis develops commonly with intraocular foreign bodies and with vegetable or soil contamination. Clinical symptoms include corneal ring infiltrate with panophthalmitis and retinal necrosis[19].

Endogenous endophthalmitis is rare and usually seen in immuno-compromised patients or patients with a history of intravenous drug abuse[19]. It results from the hematogenous spread of micro-organisms from another site of infection in the body to the eye. Of all the reported cases of endophthalmitis 2% to 15% of cases are endogenous endophthalmitis. Most commonly identified species of micro-organisms responsible for endogenous endophthalmitis include streptococcus species, *Staphylococcus pneumoniae* and *Staphylococcus viridans*. Clinical symptoms of endogenous endophthalmitis depend upon the causative organism. These may include minimal inflammation with conjunctival infection with mild anterior uveitis with or without hypopyon. Focal anterior and/or posterior segment abscesses with minimum overlaying inflammation occur. Other symptoms may include mild vitritis with snowball opacities, severe inflammation with hypopyon, dense vitritis and panophthalmitis[21].

Sterile uveitis can be caused by retained lens fragments or intraocular foreign material after cataract surgery, drug toxicity (use of thrombin or plasmin in vitreous surgery), operative trauma (iris damage, vitreous loss, etc), exacerbation of pre-existing uveitis or from other pre-existing conditions like phagolytic glaucoma, phacoanaphylactic endophthalmitis and sympathetic ophthalmia. Clinical symptoms of sterile uveitis are quite similar to infectious endophthalmitis[22].

Phacoanaphylactic endophthalmitis is a rare immune complex mediated response to lens material, which occurs over a period of time after traumatic, surgical or spontaneous disruption of the lens capsule. Clinical presentation includes photophobia, ciliary injection, cells and flare, mutton-fat keratic precipitates and posterior synechiae. It is usually unilateral and involves a traumatised eye[19].

Sympathetic ophthalmia is another rare, bilateral granulomatous panuveitis that occurs after injury or surgery to one eye. It is hard to differentiate from phacoanaphylactic endophthalmitis. The main features include bilateral involvement of eyes, presence of fundus lesions (yellow-white nodules composed of retinal pigment epithelium), choroidal thickening, keratic precipates, nodular iris infiltrates, posterior synechiae, peripheral anterior synechiae and papillitis[19].

1.2.1 Clinical features of endophthalmitis

The clinical features of endophthalmitis can vary depending on the infecting organism, co-existing inflammation and duration of disease. The main symptoms include hypopyon, which is a layering of leukocytes in the anterior chamber of the eye, pain, hyperaemia, conjunctival congestion; lid edema, vitreitis and corneal edema, fibrin deposits in the anterior chamber and on the intraocular lens and reduced or blurred vision. Endophthalmitis caused by fungal organisms usually has less inflammation and pain and slower onset. Clinical presentation is that of chronic endophthalmitis with relatively mild symptoms, which include fibrinopurulent anterior chamber exudate, vitreous snowballs and opacities.[23]

Endophthalmitis can lead to vision loss or retinal detachment in severe cases if not managed appropriately.

1.2.2 Incidence of post-operative endophthalmitis

Post-operative endophthalmitis can be encountered after any intraocular intervention. It is difficult to provide a precise estimate of the occurrence of endophthalmitis, since a very large sample size would be required. Studies in different countries have estimated the incidence of endophthalmitis. The incidence of post-operative endophthalmitis after cataract surgery has been reported in the range of 0.07% to 0.22% in different countries. In an Australian retrospective study analysing the data of 117,083 cataract surgeries over a period of 18 years (1980-1998), the incidence of post-operative endophthalmitis reported to be 0.18%[6, 12]. In a British study, involving active surveillance of patients with endophthalmitis over a period of one year (1999-2000) in which 230,000 cataract surgeries were carried out, the reported incidence of endophthalmitis was 0.14%[24]. Another British retrospective study over the span of 10 years in a single eye unit reported an incidence of endophthalmitis to be 0.16%[25]. A Norwegian study by Sandvig *et al* reported that in 71,190 cataract surgeries done in a period of three years the suspected incidence of post-operative endophthalmitis was 0.16%[26]. A Swedish national prospective study found an incidence rate of 0.059% in 188,151 cataract surgeries reviewed[27]. Another Swedish study showed 58 cases of post operative endophthalmitis in 54,666 cataract operation during 1998, giving an incidence rate of 0.1%[28]. A 14 year medical record review study in the hospital district of Southwest Finland showed that annual rate of post-operative endophthalmitis decreased from 11.1/1000 cataract surgeries in 1988 to 0.6/1000 cataract surgeries in 2000[29]. The reduction in incidence of endophthalmitis was attributed to a change in the extraction technique to phacoemulsification. In a survey of Dutch ophthalmologists, 38 cases of endophthalmitis were reported in a total of 33,750 cataract surgeries, giving an incidence rate of 0.11 %[30]. Wong *et al* reported a post-operative endophthalmitis rate in Singapore of 0.076% in a study that reviewed 44,803 cataract surgeries performed at the Singapore National Eye Institute during the period of 1996-2001[31]. A German study in which ophthalmologists were surveyed, indicated a self-reported incidence of post operative endophthalmitis of 0.014%, 267 case of post operative endophthalmitis in 340,633 cataract surgeries reported[32]. According to Effigy *et al.* the seven year incidence rate of acute-onset postoperative endophthalmitis at the Bascom Palmer Eye Institute, Miami, Florida was 0.05%, which was significantly lower than that of the previous 11 years (0.05% versus 0.09%; p= 0.031)[33]. An Indian study reported 19 cases of acute post-operative endophthalmitis in 36,072 surgeries performed in a single eye institute, giving the endophthalmitis incidence rate of 0.05%[34].

The overall incidence of post-operative endophthalmitis in western countries is low. But it is anticipated that an increase in the number of cataract procedures will lead to an increase in the number of cases of post-operative endophthalmitis. A recent review article by Taben *et al.* found an upward trend in the incidences of post operative endophthalmitis. They found a significant increase in its incidence since 2000, when the rate of endophthalmitis was 0.265% (2000-2003) in comparison with rates of 0.087% during the 1990s, 0.158% during the 1980s and 0.327% during the 1970s[35].

1.2.3 Diagnosis of endophthalmitis

Diagnosis is of paramount importance for the proper management of endophthalmitis. Endophthalmitis can be confirmed by obtaining intraocular specimens from both the aqueous and vitreous chambers. Aqueous culture alone is not beneficial because of the high rate of negative cultures in the case of postoperative endophthalmitis with positive vitreous culture[36]. A study of 138 cases of culture positive endophthalmitis by Donahue et al. reported that 80% of vitrectomy fluid samples were culture positive in comparison to 34.8% of anterior chamber specimens and 58.2% of vitreous specimens[37].

In the case of chronic postoperative endophthalmitis all intraocular plaques should be cultured. Posterior capsule plaque should be taken without compromising Intra Ocular

Lens (IOL) stability[19]. Patients suspected of sterile endophthalmitis should be cultured for both aqueous and vitreous specimens.

In the case of endogenous endophthalmitis blood, urine, cerebrospinal fluid and wound culture and smears may be useful to locate the site of primary infection and document systemic involvement. Okada *et al.* demonstrated that positive culture was obtained from at least one body cavity in more then 96% cases of endogenous endophthalmitis[38].

For post- traumatic endophthalmitis aqueous and vitreous cultures/smears along with culture of any retained intraocular foreign body should be obtained. Culture material can be obtained from the ocular surface with a sterile cotton swab. Aqueous samples can be obtained using a 5/8-inch 30 gauge needle attached to a tuberculin syringe through a limbal incision and 0.1-0.2ml fluid should be aspirated. The vitreous specimen can be obtained by needle biopsy or by the use of an automated vitrectomy instrument. Vitrectomy is a better technique to obtain the sample as it probably results in less vitreoretinal traction than aspiration with a syringe and does not increase the likelihood of obtaining a false positive culture result[37]. Beside culture tests preoperative echography should be performed to detect the presence and amount of vitreous inflammation, choroidal detachment, retinal detachment or intraocular foreign bodies after trauma. Ultrasound can establish the presence of posterior vitreous detachment, which can facilitate vitreous removal at surgery[39]. Direct inoculation of intraocular fluid specimen on to culture media is the traditional approach, specimens obtained from automated vitrectomy, which are diluted with infusion fluid can be processed by two different methods, firstly using a membrane filter system in which the specimen is passed through a 0.45µm membrane paper that concentrates the micro organisms and particulate matter. This membrane paper is then sectioned and distributed on the appropriate media. Another method is direct inoculation of the original aspirated vitrectomy specimen into standard culture bottles. A retrospective analysis of this method resulted in 91% positive culture results which were similar to results obtained by using the membrane filter system[40].

Polymerase Chain Reaction (PCR) is another technique being used for the detection of micro-organisms. It has been shown to be more successful than conventional microbiological tests[41]. PCR is a more specific and sensitive method as it can be performed using aqueous specimens with equal sensitivity of the vitreous specimen, which is routinely used for microbial culture[42]. PCR based techniques have been shown of great value in confirmation of the diagnosis of bacterial endophthalmitis in culture negative cases. Bacterial DNA can be found in 100% of specimens from patients while microbial culture yielded positive results in only 68% of specimens[43]. This technique is still not widely used in clinical practice but is very promising in the future.

1.2.4 Micro-organisms involved in post-operative endophthalmitis

The organism involved is mainly found to be Coagulase negative Staphylococci (*Staphylococcus epidermidis*) but other species such as streptococci and enterococci may also be involved. *Propionibacterium acnes* and fungi are commonly responsible for delayed-onset infections. According to the Endophthalmitis Vitrectomy Study (EVS) of the 69% of patients with confirmed microbiologic growth, 70% of these infections were caused by coagulase-negative staphylococci (*Staphylococcus epidermidis*)[44], 10% by *Staphylococcus aureus*, 9% by streptococcus species, 2% by enterococcus, 3% by other gram-negative species like pseudomonas, proteus, *Haemophilus influenzae*, klebsiella, coliform species and 6% with gram-positive species[45]. Fungal organisms are uncommon but those found included *Candida albicans*, aspergillus, cephalosporium, fusarium, voluella, and neurospora. A recent study by Recchia *et al*. of the microbial spectrum of organisms isolated from the vitreous of patients with postoperative endophthalmitis found that gram-positive bacteria accounted for 95% of all isolates and 97% of bacteria. The largest subgroup was the coagulase- negative staphylococci, consisting of 7 different species: *Staphylococcus epidermidis* (91%), *Staphylococcus warneri* (4%), *Staphylococcus haemolyticus* (2%), *Staphylococcus cohnii* and *Staphylococcus capitis* (1% each) and *Staphylococcus saccharolyticus* and *Staphylococcus hominis* (1case each). *Staphylococcus aureus* accounted for 13% of isolates; other species isolated included enterococcus and *Propionibactacterium acnes*. The gram-negative species isolated included serratia, enterobacter, pseudomonas, moraxella, flavobacterium, xanthomonas, proteus and morganella[46]. A recent study from an Indian eye institute found nocardia to be the most common organism responsible for 60% of culture-positive cases of endophthalmitis[34].

1.3 Risk factors for post-operative endophthalmitis

Several factors can contribute to the development of post-operative endophthalmitis after cataract surgery which include patient ocular flora (micro organism) that have colonised the eye surface (i.e. eyelids and conjunctiva), type of incision, surgical technique, type of intraocular lens and emergence of bacterial resistance to currently used antibiotics. Other potential risk factors may include presence of blepharitis or other ocular surface disorders, sterilization condition, operative environment, length of surgery, presence of suture, type of intraocular lenses of intraocular lens (IOL), postoperative care,[47] age and environmental factors[17].

1.3.1 Patient risk factors

Age has been found to be associated with an increased risk of endophthalmitis especially in older age (80 years or older)[17, 48].This can be attributed to reduced natural immunity.

1.3.2 Pre-operative risk factors

Micro-organisms that are present on the surface structures, such as eyelids, the lacrimal sac and the conjunctiva are primary causes of infection. These organisms generally include gram-positive aerobic bacteria, gram-negative bacteria and fungi. The mostly commonly found organism is *Staphylococcus epidermidis*; other species include S. aureus, Streptococcus species, serratia, proteus and pseudomonas. Many studies have indicated that patient's ocular surface flora are a major source of infection during cataract surgery with up to 82% similar organism isolated from aqueous and vitreous specimens[49, 50]. Due to presence of these micro organism on the surface of the eye, the pre-operative risks for postoperative endophthalmitis include blepharitis, conjunctivitis, canaliculitis, dacryocystitis, lacrimal duct obstruction, contact lens wear, an ocular prosthesis in the fellow orbit, host immunosuppression, diabetes mellitus and upper respiratory track infections[51].

1.3.3 Environmental factors

Conjunctival bacteria showed seasonal prevalence pattern as found in a study conducted by Rubio[52]. This study showed that staphylococci coagulase negative was significantly higher (> 60%) on the conjunctiva during April, May and June. A similar pattern was shown by other species in different months. This study also reported 3.37 times more case of postoperative endophthalmitis in cases where operations occurred in May and June. Li *et al*. reported a higher risk of postoperative endophthalmitis for cataract surgery performed during winter than those performed in spring (OR 1.48, 95% CI 1.00-2.18)[17]

1.3.4 Intraoperative risk factors

Intraoperative risk factors include inadequate disinfection of conjunctiva, eyelid, prolonged surgery time[19], vitreous loss, trans-scleral suture fixation of posterior chamber IOL, use of polypropylene haptic IOLs, preoperative eyelid abnormalities, unplanned ocular penetration or re-entering the eye through a previous wound, and postoperative wound defects[53].

Anterior chamber contamination during surgery

The major source of intraocular contamination is the conjunctival flora. Micro-organisms can enter the anterior chamber directly or indirectly by instruments or an intraocular lens. Studies comparing the contamination rate of the anterior chamber after phacoemulsification to that of extracapsular cataract extraction (ECCE) found that phacoemulsification has no advantage over ECCE in reducing intraoperative bacterial contamination[15, 54] though the incidences of anterior chamber contamination was higher with ECCE over phacoemulsification but it was not statistical significant. It was assumed the number of micro-organisms entering the anterior chamber preoperatively might be reduced with phacoemulsification because of a smaller incision and constant infusion of fluid at greater pressure. A study found a contamination rate of 46.25% after phacoemulsification[16],whereas other studies have found the rate of anterior chamber contamination after ECCE to be between 25.5% and 43.0%[50, 55] and after phacoemulsification of 20.0%[15].

Incision type- A risk factor for Post-operative endophthalmitis

In a retrospective, case controlled study, Cooper et al. reported clear corneal incision as a significant risk factor for post-operative endophthalmitis[56]. In this study, the surgical technique was compared between 38 culture positive cases of endophthalmitis and 371 randomly selected normal cataract cases. The group observed a three fold increased risk of endophthalmitis with clear corneal incision than with scleral tunnel incision. They attributed this to two factors: firstly, clear corneal being a newer surgical technique (surgeons were still learning to master it) secondly, a stable self sealing incision may be technically more difficult in the cornea than in the sclera.

The main feature of suture-less cataract surgery is anterior corneal lip entrance into the anterior chamber, constructed so that the inner corneal surface seals against the outer corneal surface once the eye have been repressurized. A clear corneal incision creates an internal corneal lip without the scleral component. Taben *et al*[57] suggested that intraocular pressure, location and type of incision and angle of incision all act together to determine the wound structure and hence its accessibility to potentially pathogenic organism. The study suggested that for each type of surgical wound, there is a range of angles (36°-49°) for which impact of intraocular pressure fluctuation on incision apposition may be minimised. The intermittent gaping of the incision when intra ocular pressure is varied could be a possible route of entrance of surface micro-organisms into the aqueous humor[57]. In general, for smaller angles, limbal incision resulted in better wound sealing relative to clear corneal incision.

A randomised prospective study of 11,595 small incision cataract surgeries by Nagaki *et al* reported that in the relative risk of culture proven endophthalmitis with a superior sclerocorneal incision was 4.6 times higher than that of temporal corneal incision[58]. In a German study of 340,633 cataract surgeries, multivariate analysis identified clear corneal incision as a risk factor for post operative endophthalmitis compared to scleral tunnel. Scleral tunnel incision reduced the risk of developing post-operative endophthalmitis by 65%.[32] In a Canadian study involving 13,886 cataract surgeries, the incidence of post-operative endophthalmitis with clear corneal incision was found to be 0.129% compared with 0.050% with scleral tunnel, although this difference was not statistically significant[59].

Clear corneal suture-less temporal incisions may be more prone to endophthalmitis because the wound is not protected by the eyelid or conjunctiva and is more exposed to bacteria in the tear film and eyelid margins[60]. A nine-year prospective non-comparative consecutive case series study concluded that clear cornea cataract surgery under topical anaesthesia was safe and resulted in fewer post-operative complications and stated clear cornea surgery helps is early recovery of vision, rehabilitation of patient's lifestyle and astigmatism control[61]. A prospective randomized multi-centre study comparing the complications and outcome of scleral tunnel incision with PMMA IOL implantation and clear corneal incisions with foldable IOL implantation concluded both incision techniques to be safe and similar in intraoperative stability[62].

Present data does not conclude anything substantive about the incision type as a risk factor for postoperative endophthalmitis. Further studies are required to establish incision type as a putative risk factor for post-operative endophthalmitis.

Intra-ocular lens

Bainbridge et al showed an increased risk of post-operative endophthalmitis after cataract surgery with the use of a three piece silicon IOLs. [63] It is thought that the IOL material and shape could prompt bacterial contamination before implantation or that it decreased susceptibility of intraocular organisms to physiological or pharmacological bacterial defence[63]. Micro-organisms can adhere to the surface of the intraocular device surface by reversible adsorption through physical forces such as electrostatic charges and hydrophobicity, and by irreversible adherence from bacterial production of a polysaccharide biofilm. A biofilm is a functional consortium of micro-organisms organised within an extensive exopolymer matrix. This confers relative protection from humoral and cellular immunity and from antibiotics. Raskin *et al.* showed a two-fold greater adherence of *Staphylococcus epidermidis* to IOL with polypropylene haptics compared with PMMA lenses using quantitative culture methods, radioisotope techniques, and scanning electron microscope. Griffiths *et al*. showed the adherence of bacteria to IOL in vitro appears to confer greater resistance to antibiotics. An in-vitro experiment by Cusumano *et al.* demonstrated increased growth of micro-organisms on the surface of silicon IOLs.

The resistance to antibiotics and enhancement of bacterial growth may be attributed to differences in the surface properties of the different IOL types with differing propensities to form biofilms[64]. Silicon IOL is more hydrophobic than PMMA and it has been hypothesised this increases the risk of bacterial contamination and subsequent endophthalmitis[65]. Many studies have shown that silicon IOLs significantly increases the risk of post-operative endophthalmitis[27, 65]. Adherence of bacteria to IOLs is likely to occur during the period immediately before implantation. The presence of a therapeutic level of antibiotics at the time of IOL implantation may be effective in limiting further bacterial proliferation. The use of injectable IOLs has been shown to significantly lower the incidence of post-operative endophthalmitis[25]. This has largely been attributed to the fact that an injectable lens does not make contact with the ocular surface, thereby reducing the risk of microbial contamination.

From the available literature it can be concluded the material of the IOL does affect the incidence of post-operative endophthalmitis after cataract surgery. Other coexisting ocular conditions need to be considered in the selection of the appropriate IOL.

Post-operative risk factors

Post-operative risk factors include wound leakage or dehiscence, inadequately buried suture, sutured wound, inappropriate suture removal, vitreous incarceration in the surgical wound and the presence of filtering bleb[66].

1.4 Prevention of post-operative endophthalmitis

Different measures are taken to prevent the occurrence of endophthalmitis; these may include sterile surgical techniques and pre-operative and post-operative antibiotic prophylaxis [67].

Application of an antiseptic like povidone-iodine to the skin and conjunctiva is frequently used. Sterile surgical techniques also reduce the incidence of post-operative endophthalmitis. Some surgeons also use pre-operative topical antibiotics.

Peri-operative antibiotics for prophylaxis can be administrated topically, subconjunctivally or intracamerally. The selection of the antibiotic depends upon the bacterial spectrum of the agent. Frequently used antibiotics include chloramphenicol, vancomycin, fluoroquinolones, and cephalosporins [67, 68].

As mentioned in an earlier section different risk factors have been defined for post-operative endophthalmitis after cataract surgery. Different measures are generally taken for the prevention of post-operative endophthalmitis, including pre-operative antibiotic prophylaxis, use of antiseptics before, during and after the surgery and post-operative antibiotics. Sterile surgical techniques also reduce the incidence of post-operative endophthalmitis[32, 47, 69, 70].

1.4.1 Principles of prophylactic therapy

The aim of prophylaxis in cataract surgery is to prevent post-operative endophthalmitis or surgical wound infection. Different principles are given for the most appropriate use of antibiotics for chemoprophylaxis[71-73]. Many studies have shown that chemoprophylaxis with use of antiseptics and antibiotics are effective in lowering the incidence of post-operative endophthalmitis[70, 73-75]. Although the need for chemoprophylaxis in clean surgery has been debated among general surgeons, it was universally accepted among ophthalmologists because of the severity of adverse effects associated with postoperative endophthalmitis.

Prophylactic antibiotics should be used only when there is an appropriate indication. Potential pathogens and resistance patterns must be identified and the most appropriate antibiotic should be selected. It is not necessary to cover all organisms or to sterilize the operation site, but most bacteria must be eliminated from the site. The least toxic and least expensive antibiotic should be used. The antibiotic must be administrated at an appropriate time and dose. The antibiotic must be in the wound or anterior chamber at the time of introduction of the organisms. To eliminate bacteria from the surface, topical antibiotic must be used before the intervention so that sufficient time is given to clear any organisms. The antibiotic used as prophylaxis should have as short duration as possible. Potent antibiotics should be avoided for prophylaxis as they must be reserved for therapy. The U. S. Centre for Disease Control and Prevention has cautioned against the generalized use of antibiotics such as vancomycin because of the potential for emergence of vancomycin-resistant strains of coagulase-negative staphylococcus and enterococcus.[76] If patients develop post-operative infection after the use of chemoprophylaxis, different antibiotics should be used for treatment. If prophylactic antibiotic are used, they should be bactericidal against gram-positive and gram-negative bacteria[77].

1.4.2 Endophthalmitis prophylaxis

Ocular surface flora are most common causes of post-operative endophthalmitis[30, 74]. Speaker *et al*. found that in 82% of cases of endophthalmitis, an organism isolated from the vitreous was genetically indistinguishable from isolated external flora of the eye[49]

Antisepsis

Use of antiseptics has been found to be effective in reducing surface bacteria in both general surgical and ophthalmic interventions. Povidone–iodine is an effective antiseptic with rapid activity against most bacteria, fungi, viruses, protozoa and spores[78]. It acts by releasing free iodine and persists for at least one hour. Povidone-iodine (Betadine®) solution is an excellent antiseptic and is always recommended for both skin and conjunctiva. When used as a 1% or 5% solution before the surgical incision, it decreases substantially the number of organisms present on the conjunctiva[49, 79]. It may also be useful in the post-operative period in slowing the increase of bacteria in the conjunctival sac[80]. However it must also be used cautiously because it has been demonstrated to be toxic to the corneal endothelium[81].

Antibiotics

Antibiotics are widely used to prevent endophthalmitis. The physiochemical properties of drugs may affect permeability across the sclerocorneal surface. Third generation cephalosporin like ceftazidime and ceftriaxone, achieve the highest vitreous concentration after intravenous administration. With an intact corneal endothelium, lipid-soluble antibiotics such as chloramphenicol penetrate better than the less lipid soluble agents[21]. Quinolone antibiotics can penetrate the aqueous, have high solubility to reach therapeutic concentrations and are minimally toxic[82].

1.4.3 Modes of delivery of antibiotics to the eye

Topical antibiotics

Antibiotics can be administrated in to the eye topically using eye drops or ointment. Topical antibiotics are widely used for many ophthalmic conditions ranging from conjunctivitis to endophthalmitis, and topical antibiotics are often used for chemoprophylaxis for cataract surgery. Topical antibiotics reduce or eliminate the bacterial load on the ocular surface and penetrate into aqueous fluid to eliminate bacteria, which entered at the time of intervention. Topical antibiotics do not completely sterilize the conjunctiva and there are concerns that prolonged administration may select out resistant bacterial strains. Prophylactic use of antibiotic is costly and could lead to the development of resistance as well as cause allergic reactions[19]. Chloramphenicol is a broad spectrum antibiotic. It is bacteriostatic in action and unpredictably active against staphylococci[83]. The antibiotics that are currently used include aminoglycoside, polymyxin B, fluoroquinolones, and chloramphenicol. For pre-operative antibiotics use, the duration of therapy should be limited to one to two days to prevent development of antibiotic resistance[77]. The ideal antibiotic for topical use should have a broad spectrum of coverage, negligible side effects and should be fast acting.

Penetration of topical ocular antibiotic

Jenson *et al.* reported significantly higher rates of post-operative infection with the use of topical ciprofloxacin compared to ofloxacin ($P < .00026$) and attributed it to differences in pharmacokinetic and pharmacokinetic properties of the antibiotics[84]. The tear film is at neutral pH (pH 7.2 to 7.4). Ciprofloxacin has a pH of 4.5 and will precipitate when used frequently.[85] In contrast ofloxacin has pH of 6.4, much closer to the pH of tear film and does not precipitate in ocular fluid or tissue. Ofloxacin also being lipophilic readily penetrates the corneal epithelium. Ofloxacin has approximately four times higher corneal and anterior chamber penetration than ciprofloxacin[86]. For an antibiotic to be effective against micro-organisms inside the anterior chamber the antibiotic must be present above the minimum inhibitory concentration (MIC). Penetration of these antibiotics through an inflamed cornea was reported to be good and effective in treatment of bacterial keratitis[87]. However when used peri-operatively in cataract surgery with intact corneas and minimum inflammation higher intraocular concentration of antibiotic is necessary.

Antibiotics administrated with irrigation fluid

Antibiotics can also be added to irrigation fluid during surgery. Vancomycin tends to be favoured because of its spectrum against gram-positive bacteria. Mendivil *et al*. reported a lower rate of positive culture in patients treated with vancomycin in an irrigation fluid, but also reported the short half-life of vancomycin in the eye[75].

Subconjunctival antibiotics

Antibiotics can be administrated under the conjunctiva by injection. There is some leakage of antibiotic back into the tears of the conjunctival sac. Subconjunctival injection of antibiotics are effective[88, 89] since significant aqueous concentration can be achieved, although the vitreous concentration of all single subconjunctival injections is extremely low. Liesegang suggests that subconjunctival antibiotics are best delivered pre-operatively to obtain aqueous levels at the time when any micro-organisms are introduced into the eye[73].

Sub tenon's injection

A sub tenon's injection is injected more deeply into the orbit. It achieves higher concentrations in the posterior chamber than the subconjunctival injection. Periocular injection is better tolerated if given under topical anesthesia. It may be associated with complications like conjunctival ischemia and necrosis at site of the injection, especially if aminoglycoside antibiotics are used.

Intravitreal injection

Intravitreal antibiotic injection is a standard treatment for endophthalmitis and is not used for the chemoprophylaxis. Antibiotics remain at an effective concentration for a long time and only a small volume (0.1 to 0.2ml) is injected and an equal volume of vitreous fluid is withdrawn to maintain the intra-ocular pressure and give a specimen for culture. The injection is entered via pars plane to avoid retinal perforation and detachment. Cationic drugs such as gentamycin have a longer half-life in the vitreous than anionic drugs like penicillin which get actively transported out of the vitreous. Vancomycin (dose-1.0mg/0.1ml) is the most common intravitreal antibiotic administered as it is effective against most gram positive bacteria including methicillin resistant staphylococcus aureus[46, 90, 91]. Ceftazidime (dose -2.25ml/0.1ml), a third generation cephalosporin, is commonly used with vancomycin to provide coverage for gram-negative bacteria. Ceftazidime was found to be effective in 100% of gram negative organisms causing postoperative endophthalmitis whilst amikacin (dose -0.4mg/0.1ml) was effective against 97% of organisms[92]. Vancomycin and ceftazidime must be injected in separate syringes to avoid precipitation when combined together.

Intra-operative and post-operative use of antibiotic

Beside the pre-operative use of antibiotics and antiseptics, antibiotics are also used during and after cataract surgery. There is a lack of data proving benefit for postoperative topical antibiotics despite wide-spread use by ophthalmologists. Colleaux *et al*. reported no statistically significant difference in incidence of post-operative endophthalmitis with use of pre-operative antibiotics[59]. The rationale for use of post-operative topical antibiotic is that it reduces surface bacterial contamination in the post-operative setting until the wound is healed. Some antibiotics can achieve sufficient levels in the anterior chamber to prevent bacterial growth[73] as discussed earlier.

1.4.4 Chemoprophylaxis and bacterial resistance

Development of resistance against antibiotics has been an issue in the use of antibiotics for chemoprophylaxis. Many recent studies have found that pathogens causing post-operative endophthalmitis are changing and resistance is increasing to antibiotics currently being used[46]. A study by Recchia *et al*. found a statistically significant increase in resistance of gram-positive bacteria to ciprofloxacin and in the resistance of coagulase-negative staphylococci to ciprofloxacin and to cefazolin, over the periods 1989 to1994 and 1995 to 2000. Resistance to bacitracin, vancomycin and trimethoprim-sulfamethoxazole remained statistically unchanged. Seppala *et al*. confirmed these findings, and reported a statistically insignificant change in the resistance to vancomycin and chloramphenicol but increased resistance to other antibiotics such as tetracycline, erythromycin, penicillin, clindamycin, levofloxacin and moxifloxacin.[91]

Before using an antibiotic for chemoprophylaxis the ophthalmologist must be aware of suspected bacterial pathogens and the effectiveness of an antibiotic against the pathogens. The reduced efficacy of frequently used antibiotics such as ciprofloxacin and cefazolin must be considered before using them for the management of postoperative endophthalmitis[46].

1.5 Future trends in endophthalmitis prophylaxis

Other than regular methods of chemoprophylaxis such as the use of antiseptics and antibiotics, newer techniques are on the horizon. The use of ozonated solution was found to be safe and effective in ophthalmology[93, 94].

Ozone acts by the oxidation of organic compounds with subsequent cytolysis of bacteria and hence there is no concern about the development of resistance[95], but the main adverse effect of ozone is oxidative tissue damage. The corneal endothelium is of particular importance because it cannot regenerate. Takahashi *et al.* showed that 4ppm ozonated solution has potent bactericidal action with limited corneal endothelium damage but this study could not establish the safety of ozone as a regular method of chemoprophylaxis and recommended further investigation.[96]

Heparin in solution reduces bacterial adhesion to intraocular lenses and lower incidence of postoperative endophthalmitis has been reported with the use of heparin coated IOLs.[97] The role of heparin in prevention of endophthalmitis is still not established and it has no direct antimicrobial effect. It has been suggested that heparin could act by either coating the surface or by coating the bacteria and thus preventing adherence. But this mechanism does not explain the effectiveness of heparin when used in solution. Experimental proof is lacking, but it is expected that heparin interferes with the binding sites on the bacterial surface and therefore prevent adherence to the lens[97]. Bayramlar *et al.* reported decreased postoperative inflammation with use of heparin sodium in irrigation solutions.[98] The most significant risk with the use of heparin is that of bleeding and postoperative hyphema. The study recommended use of low-molecular-weight heparin to prevent adverse effects[98].

1.6 Costs versus benefit of chemoprophylaxis

Endophthalmitis is a major cause of ocular morbidity and can result in visual impairment and blindness in 70% of cases[12]. An American study estimated that the minimum cost of treating each case of endophthalmitis was US $ 13,000. This represented a total estimated cost of endophthalmitis management of US $ 17.6 million a year.[99] In Australia the true economic costs of treatment of endophthalmitis are unknown. An initial estimate using American data showing the total cost to the Australian health care system may be high as $ 4million.

The current cost of chemoprophylaxis in Australia may be derived from the frequency identified in the pilot study by Morlet *et al*. and pharmaceutical costs as specified by the Pharmaceutical Benefit Scheme, which gives an estimate of $ 0.95 million per annum.[100]

A German study estimated the cost of a single case of endophthalmitis to be € 3831.47 and the total cost to be € 819,934.58 per year for 291 cases of post-operative endophthalmitis reported by German surgeons. The study found that use of intraocular intraoperative gentamycin prophylaxis would result in an annual cost saving of about € 368, 822.[101]

Accurate cost data on treating post-operative endophthalmitis and what are the most effective chemoprophylaxis methods would enable a better estimate of the costs involved to prevent and to treat the disease and is required for developing appropriate economic models and evidence- based clinical guidelines.

2 OBJECTIVES

The objectives of the project are as following:

1. Describe regional differences in the techniques of cataract surgery.

2. Examine the effect of demographic factors, different surgical practices and chemoprophylactic regimens on the self reported incidence of postoperative endophthalmitis by cataract surgeons. .

3. Estimate the costs of treating cases with post operative endophthalmitis.

4. Conduct a cost analysis of chemoprophylaxis for cataract surgery.

5. Determine the number of cases of post-operative endophthalmitis that would need to be prevented to offset the additional cost of using alternative chemoprophylactic regimens and surgical techniques.

6. Compare current practices in cataract surgery and occurrence of postoperative endophthalmitis with those in a survey conducted approximately 10 years ago

3 METHODOLOGY

3.1 Ethics

Approval for collecting information from ophthalmologists for this study was obtained from the University of Western Australia Ethics Committee (Appendix 1) and Western Australia Health Department's Confidentiality of Health Information Committee (CHIC) approved the hospital medical record review and economic evaluation component of this survey (Appendix 2).

3.2 Data collection and analysis

The two main sources of data for this study were a postal survey of ophthalmologists and information relating to the management and cost of post-operative endophthalmitis.

3.2.1 Survey of ophthalmologists

Questionnaire

A questionnaire was mailed to all fellows and trainee members of the Royal Australian and New Zealand College of Ophthalmology (RANZCO) in March 2004 with a reply paid envelope. Reminders were sent to the ophthalmologists who had not returned questionnaires in May and September 2004. The questionnaire (Appendix 3) was divided into four main sections - surgeon demographics, surgical workload/endophthalmitis cases, chemoprophylactic regimens and clinical details of endophthalmitis cases.

The first section of the questionnaire focused on the demographics of participating surgeons. Questions were asked about the age, sex and experience of surgeons and the location of their practices.

The second section addressed issues relating to surgical workload (e.g. average number of cataract surgeries performed per month) and the number of cases of endophthalmitis during 2003.

The third section dealt with issues relating to surgical practices such as whether patients were hospitalised prior to or after the surgery, the percentage of patients hospitalised, reasons for hospitalisation, the method of cataract removal, the type of anaesthesia used, the location and type of incision, and the use of sutures.

The final section examined chemoprophylaxis practices used by the surgeons and included questions such as the use of preoperative topical antibiotics, intra-operative antibiotics/antiseptics and post-operative antibiotics and steroids and the duration of this use.

Data Transcription

Data from the returned questionnaires were entered into SPSS® Version 12.0 for Windows®. A primary data sheet was created that contained the responses of all participating surgeons. This data sheet was cross checked with the original questionnaires to identify any mistakes made while entering the information and a secondary data sheet was created after cross checking. Surgeons who had returned incomplete questionnaires and those who had not performed cataract surgeries or had performed less than 12 during 2003 were omitted from the final data sheet.

Data Analysis

The descriptive analysis was performed in SPSS® Version 12.0 for Windows® (SPSS Science, Chicago, IL). Frequencies and means of variables were calculated and selected cross-tabulations computed to determine variations in surgical practice and other variables by factors such as region, age gender and experience.

The statistical analysis was performed in SPSS® Version 12.0 and STATA 8® (Statistical software: release 7.0, Stata Corporation, College Station, TX)[102]. Multivariate Poisson regression analysis was performed to determine factors associated with the self reported incidence of post-operative endophthalmitis. Each surgeon's self reported number of cataract surgery procedures and cases of endophthalmitis were used to calculate the self reported incidence rate of endophthalmitis which was used as the main dependent variable. For each independent variable or risk factor, one level was selected as the reference and the regression coefficients were calculated for other categories using multivariate poisson regression modelling.

3.3 Management and cost of post-operative endophthalmitis

3.3.1 Study sample

From a previously described cohort of post-operative endophthalmitis[17] cases, there were 69 patients treated for post-operative endophthalmitis between 1997 and 2000 in seven different hospitals (five metropolitan and two regional hospitals) in Western Australia. Of the 61 patients who were treated for post-operative endophthalmitis after cataract surgery in four of the metropolitan hospitals, the medical records of 46(75.4%) patients were available for review. Length of stay information was available for three extra patients for whom medical records were not available (These patients were treated at Hospital B).

3.3.2 Management of post-operative endophthalmitis

Relevant data from the medical records were recorded on data collection forms (Appendix 4). The information collected included length of hospital stay, type of treatment, vitrectomy, use of intra-vitreal antibiotics or vitreous tap, diagnostic tests such as microbiological and culture, other investigations and the other medications used. Information relating to the number of hospital out-patient visits was collected from the ophthalmology out-patient departments of the respective hospital.

3.3.3 Cost of post-operative endophthalmitis

Hospital inpatient costs for managing the cases of post-operative endophthalmitis were obtained from the accounting and business departments of the four Perth hospitals. The data was entered into an Excel spreadsheet. The costs were for the year in which patients were treated. In order to make the cost data for patients comparable, all costs were adjusted to a base year of 2005 using the health price index developed by the Australian Institute of Health and Welfare[103].

Outpatient visits were valued using the standard cost for Australia calculated in the Hospital Utilisation and Costs Study.[104] The total cost of outpatient visits for each patient was calculated by multiplying the number of out-patient visits with the cost of an outpatient visit.

The final cost of an episode of post-operative endophthalmitis was calculated by adding the cost of hospitalisation adjusted to the base year of 2005 to the cost of out-patient visits.

3.4 Cost of chemoprophylaxis

The cost of chemoprophylaxis use per patient was obtained from the hospital pharmacies of the four Perth hospitals. The subconjunctival antibiotic injection was selected as chemoprophylaxis method for cost analysis as multivariate Poisson regression analysis showed that it significantly reduces the incidence of post-operative endophthalmitis. Gentamycin was selected as the antibiotic for the cost analysis, because the survey of cataract surgeons showed gentamycin to be the most commonly used subconjunctival antibiotic in Western Australia (31% users). The cost of subconjunctival gentamycin included the hospital acquisition cost of the antibiotic in addition to the cost of syringes and needles as these injections are usually prepared in operation theatre by the surgeon before administration. Cost for gentamycin and consumables were obtained from the hospital pharmacy of hospital A.

3.5 Cost analysis

3.5.1 Base case analysis

Base case analysis was performed by considering two scenarios as shown in table 3.1. In Scenario 'A' surgeries in which no subconjunctival antibiotics chemoprophylaxis was used were considered and the number of cases of endophthalmitis were valued to get the cost of endophthalmitis without the use of subconjunctival antibiotics. In Scenario 'B' it was assumed the subconjunctival gentamycin injection was used in all the surgeries. As the multivariate poisson regression analysis showed reduced incidence risk ration ratio with use of subconjunctival antibiotics, the number of cases of endophthalmitis that will still occur will be calculated and entire scenario will be valued by adding cost of chemoprophylaxis plus the cost of treatment of endophthalmitis

Table 3.1 Base cost analysis

Scenario 'A'	Scenario 'B'
No subconjunctival antibiotic used	Subconjunctival gentamycin used in all cataract procedures
Cost of Scenario 'A' = cost of treatment of cases of post-operative endophthalmitis	Cost of Scenario 'B' = cost of chemoprophylaxis + cost of treatment of post-operative endophthalmitis.
Cost saving = Cost of Scenario 'A'- Cost of Scenario 'B'	

3.5.2 Break even analysis

Break even analysis was performed to determine the number of cases of endophthalmitis that must be prevented to offset the additional cost of chemoprophylaxis. This can be determined by dividing the cost of chemoprophylaxis regimen by the cost of treatment of single episode of endophthalmitis. The new relative risk ratio calculated and percentage reduction reported.

3.5.3 Sensitivity analysis

Sensitivity analysis was performed to examine the impact of varying the values of key variables and recalculating the findings. The key variables in this analysis were cost of gentamycin injection and hospital cost of treating post-operative endophthalmitis. The cost of gentamycin was increased by 100% and decreased by 50% to determine the stability of result. For the hospital cost of endophthalmitis the maximum and minimum costs reported by Perth's hospitals were taken as increased and decreased value respectively.

4 RESULTS

4.1 Survey response

The questionnaire was mailed to all fellows and trainee members of the Royal Australia and New Zealand College of Ophthalmology in March 2004. Of the 896 members, 731 (81.6%) returned questionnaires. Of these 731 respondents, 20 declined to participate and 131 did not perform cataract surgery. A further forty respondents either did not satisfactorily complete the questionnaires or performed fewer than 12 cataract procedures during 2003 and were excluded from the analysis. This left a sample of 540 participants in the study (Table 4.1).

Table 4.1 Number of ophthalmologists, cataract surgeons and study respondents

Population and sample characteristics	NSW	Vic	Qld	WA	SA	ACT	NT	Tas	NZ	Total
Total number of ophthalmologists(2003)	311	196	119	66	63	9	5	13	114	896
Responders	242	161	91	65	53	8	5	12	94	731
Number of cataract surgeons	189	124	73	57	35	8	4	10	80	580
Number of cataract surgeons in study	176	114	64	55	35	7	4	9	76	540

4.2 Background information

4.2.1 Distribution of cataract surgeons in Australia and New Zealand

The number of ophthalmologists in Australia and New Zealand in 2003 per 100,000 of population was 3.7 (896 ophthalmologists for population of 23,881,846) (Table 4.2). New South Wales had the highest rate of 4.6 ophthalmologists per 100,000 of population while Northern Territory has lowest rate of 2.5 per 100,000 of population. The Australian Capital Territory and Northern Territory had no active female cataract surgeon during 2003. Overall the male:female ratio of participating cataract surgeons ratio was 5.8:1. Queensland and Western Australia had the highest ratio of 15.0 and 12.7 respectively. In comparison, Victoria and New South Wales had the lowest male:female ratio of 3.9 and 4.3 respectively.

The mean age of participating cataract surgeons ranged from 41.5 years in the Northern Territory to 50.7 years in the Australian Capital Territory. The average work experience of participating cataract surgeon was about 15 years with the most experienced cataract surgeon in the Australian Capital Territory, with an average experience of over 18 years and the least experienced in the Northern Territory, with an average experience of 11 years.

Table 4.2 Distribution, demographics and work experience of cataract surgeons

Selected indicators	NSW	Vic	Qld	WA	SA	ACT	NT	Tas	NZ	Total
Number of opthalmologists/100,000 population	4.6	3.9	3.1	3.3	4.1	2.7	2.5	2.7	2.8	3.7
Number of study participants /100,000 population	2.8	2.5	1.9	2.3	2.4	2.4	2.0	2.1	2.0	2.2
Male: female ratio of study participants	4.3	3.9	15.0	12.7	6.0	N/A	N/A	8.0	7.4	5.8
Mean age of study participants(years)	46.0	43.9	47.7	44.6	46.8	50.7	41.5	49.4	46.1	45.8
Average experience as cataract surgeon (years)	15.8	13.4	16.2	12.4	16.7	18.4	11.0	15.7	14.4	14.9

4.3 Surgical workload/cases of endophthalmitis

4.3.1 Number of cataract procedures

Table 4.3 shows the number of cataract procedures reported by survey participants. The total number of cataract operations performed by these cataract surgeons in 2003 was 162,120. The monthly average number of cataract procedures per surgeon was 25.1, with the Australian Capital Territory and Tasmania having higher averages of 39.8 and 34.4 respectively. In all other jurisdictions, surgeons performed a similar annual number of cataract procedures.

Table 4.3 Number of cataract procedures

Cataract procedures	NSW	Vic	Qld	WA	SA	ACT	NT	Tas	NZ	Total
Reported number of procedures	51,840	32,142	21,276	14,994	11,940	3348	720	3720	22,140	162,120
Average monthly procedures/surgeon	24.5	23.5	27.7	22.7	28.4	39.8	15.0	34.4	24.3	25.1

4.3.2 Cases of post-operative endophthalmitis

Participating ophthalmologists reported a total of 92 cases of post-operative endophthalmitis (Table 4.4). The cumulative incidence of self-reported cases of post-operative endophthalmitis was 0.056%. The range in reported rates of post-operative endophthalmitis was considerable. The Northern Territory and Queensland recorded the highest cumulative incidence of post-operative endophthalmitis of 0.555% and 0.564% respectively, while New Zealand and Victoria had the lowest rates of 0.036% and 0.034% respectively.

Table 4.4 Number of reported cases of post-operative endophthalmitis

Endophthalmitis	NSW	Vic	Qld	WA	SA	ACT	NT	Tas	NZ	Total
Number of reported cases	34	11	12	12	5	3	4	3	8	92
Cumulative incidence rate (%)	0.066	0.034	0.564	0.080	0.042	0.090	0.555	0.081	0.036	0.056

4.4 Operative Technique

4.4.1 Location of cataract surgery by the type of hospital

Table 4.5 shows the location used where cataract procedures were performed. Overall 41% of cataract procedures were conducted in public hospitals and 59% in private hospitals. Across the region there were quite marked differences in locations used for cataract procedures. Relatively high numbers of cataract procedures were performed in public facilities in Victoria, Western Australia Northern Territory and New Zealand. All other jurisdictions had a relatively high number of cataract procedures conducted in private facilities.

Table 4.5 Percentage distribution of cataract procedures by type of hospital

Site of cataract procedure	NSW (%)	Vic (%)	Qld (%)	WA (%)	SA (%)	ACT (%)	NT (%)	Tas (%)	NZ (%)	TOTAL (%)
PTH*	28.5	43.2	26.1	19.0	29.2	12.9	62.5	15.0	28.9	29.5
PNTH**	9.5	4.5	2.6	30.4	10.1	20.7	12.5	-	15.2	11.7
% procedure performed in public hospitals	38.0	47.7	28.7	49.4	39.3	33.6	75.0	15.0	44.1	41.2
PH§	32.6	34.3	22.1	29.6	43.3	29.4	25.0	28.1	27.3	30.2
PDCF§§	29.4	18.0	49.2	21.0	17.4	37.0	-	56.9	28.6	28.6
% procedure performed in private hospitals	62.0	52.3	71.3	50.6	60.7	66.4	25.0	85.0	55.9	58.8
Total	100	100	100	100	100	100	100	100	100	100

*PTH- Public Teaching Hospital, **PNTH- Public Non Teaching Hospital, §PH- Private Hospital, §§PDCF- Private Day Care Facility.

4.4.2 Hospitalization of patients before/after cataract surgery

Table 4.6 shows extent of pre-operative and post-operative hospitalization of patients before and after cataract surgery. Only 3% of respondents admitted their patients before cataract surgery while 18% admitted patients after the surgery (Figure 4.1). No surgeons hospitalized patients before surgery in New Zealand, South Australia, ACT, and Tasmania. According to survey respondents the majority of patients who were admitted to hospital post-operatively were either aged or were living alone.

Table 4.6 Hospitalization of patients before and after cataract surgery

Hospitalization	NSW	Vic	Qld	WA	SA	ACT	NT	Tas	NZ	Total
Hospitalization before surgery	1 (0.6%)	3 (2.6%)	2 (3.1%)	9 (16.4%)	-	-	1 (25%)	-	-	16 (2.9%)
Hospitalization after surgery	33 (18.8%)	25 (21.9%)	14 (21.9%)	13 (23.6%)	3 (8.6%)	1 (14.3%)	2 (50%)	1 (11.1%)	6 (7.9%)	98 (18.2%)

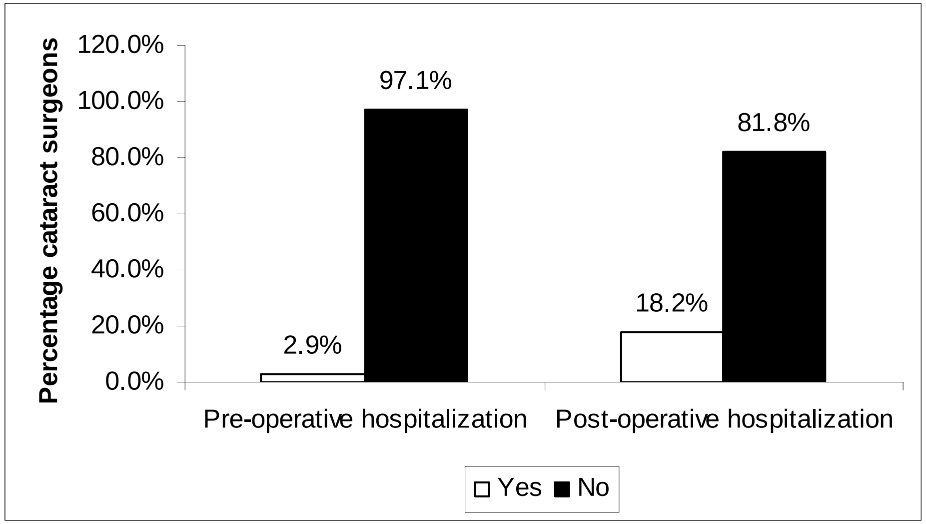


Figure 4.1 Hospitalization of patient before and after cataract

4.4.3 Method of cataract removal

Figure 4.2 shows the cataract extraction techniques used by the survey respondents. Phacoemulsification was the most common method for cataract removal and accounted for 98.1% of cataract procedures. Other techniques of cataract removal were much less used. Extra Capsular Cataract Extraction (ECCE) was used in just 1.5% of cataract procedures; around 0.4% of cataract procedures were done using other methods of cataract removal which may include ICCE, lensectomy and others.

4.4.4 Type of anaesthesia

Table 4.7 shows the use of different methods of anaesthesia by the survey respondents. Peribulbar was most common type of anaesthesia used by cataract surgeons in performing cataract procedures, followed by topical anaesthesia and sub-tenons injection of anaesthetic and retrobulbar administration of anaesthesia.

Type of anaesthesia varied by jurisdiction. Other than Tasmania, the type of anaesthesia technique used most commonly by cataract surgeons was peribulbar, although this was less pronounced in Western Australia than elsewhere. In Tasmania, however, the most commonly used type of anaesthesia was topical anaesthesia. In New Zealand the majority of cataract procedures were performed under subtenons anaesthesia.

Table 4.7 Percentage distribution of anaesthesia techniques for survey respondents

Anaesthesia technique	NSW (%)	Vic (%)	Qld (%)	WA (%)	SA (%)	ACT (%)	NT (%)	Tas (%)	NZ (%)	Aggregated %
Retrobulbar	7.8	27.8	4.1	13.4	15.6	0.4	25	8.5	4.4	11.9
Peribulbar	51.8	54.2	56.5	35.0	68.3	82.1	49.7	11.5	17.2	47.4
Subtenons	18.2	4.6	12.3	8.2	0.7	12.5	25	11.9	62.8	17.4
Subconjunctival	0.7	0.3	0.5	7.0	-	0.7	-	2.5	-	1.3
Topical	20.6	10.3	24.2	27.6	15.1	4.0	-	56.0	14.4	19.1
GA	0.9	2.8	2.4	8.8	0.3	0.3	0.3	9.6	1.2	2.9
Total	100	100	100	100	100	100	100	100	100	100

4.4.5 Wound incision location and technique

Table 4.8 shows the participating cataract surgeons responses to questions relating to incision technique and location of incision. The most common incisions location in all jurisdictions was clear corneal. It was used by 73% of participating cataract surgeons. Other wound locations used were limbal incision (17%) and scleral incision (10%).

The preferred wound approach was temporal position, which was used by 57% of surgeons. This was the preferred wound approach of cataract surgeon in all jurisdictions with the exception of Western Australia, where the preferred incision approach was the superior position (56%) followed by the temporal position (29%).

Table 4.8 Location and technique of incision

Incision location & technique	NSW	Vic	Qld	WA	SA	ACT	NT	Tas	NZ	Aggregated %
Incision location										
Superior	50 (28.4%)	44 (38.6%)	11 (17.2%)	31 (56.4%)	6 (17.1%)	2 (28.6%)	2 (50%)	3 (33.3%)	23 (30.3%)	172 (31.8%)
Temporal	110 (62.5%)	58 (50.9%)	42 (65.6%)	16 (29.1%)	24 (68.6%)	4 (57.1%)	2 (50%)	6 (66.7%)	46 (60.5%)	308 (57.1%)
Other	16 (9.1%)	12 (10.5%)	11 (17.2%)	8 (14.5%)	5 (14.3%)	1 (14.3%)	-	-	7 (9.2%)	60 (11.1%)
Total	176 (100%)	114 (100%)	64 (100%)	55 (100%)	35 (100%)	7 (100%)	4 (100%)	9 (100%)	76 (100%)	540 (100%)
Technique										
Clear cornea	135 (76.7%)	80 (70.2%)	50 (78.1%)	31 (56.4%)	27 (77.1%)	4 (57.1%)	4 (100%)	8 (88.9%)	56 (73.7%)	395 (73.2%)
Limbus	29 (16.5%)	21 (18.4%)	7 (10.9%)	16 (29.1%)	5 (14.3%)	1 (14.3%)	-	1 (11.1%)	11 (14.5%)	91 (16.8%)
Sclera	12 (6.8%)	13 (11.4%)	7 (10.9%)	8 (14.5%)	3 (8.6%)	2 (28.6%)	-	-	9 (11.8%)	54 (10.0%)
Total	176 (100%)	114 (100%)	64 (100%)	55 (100%)	35 (100%)	7 (100%)	4 (100%)	9 (100%)	76 (100%)	540 (100%)

4.4.6 Use of sutures

Table 4.9 shows that the majority of cataract surgeons who participated in the study did not use sutures (94%). This was the case in all jurisdictions

Table 4.9 Use of sutures

State	Users	Non users	Total
NSW	15(8.5%)	161(91.5%)	176(100%)
Vic	2(1.8%)	112(98.2%)	114(100%)
Qld	3(4.7%)	61(95.3%)	64(100%)
WA	4(7.3%)	51(92.7%)	55(100%)
SA	2(5.7%)	33(94.3%)	35(100%)
ACT	1(14.3%)	6(85.7%)	7(100%)
NT	-	4(100%)	4(100%)
Tas	-	9(100%)	9(100%)
NZ	3(3.9%)	73(96.1%)	76(100%)
Total	30(5.6%)	510(94.4%)	540(100%)

4.5 Chemoprophylaxis for cataract surgery

4.5.1 Use of pre-operative topical antibiotics

Table 4.10 shows that pre-operative topical antibiotics were not widely used prophylaxis against prevention of endophthalmitis. Across all jurisdictions, only 37% of cataract surgeons used pre-operative topical antibiotics. South Australia was the only jurisdiction where the majority of cataract surgeons used topical antibiotics before cataract surgery(69%).

Table 4.10 Pre-operative use of antibiotics

State	Users	Non users	Total
NSW	93(52.8%)	83(47.2%)	176(100%)
Vic	14(12.3%)	100(87.7%)	114(100%)
Qld	29(45.3%)	35(54.7%)	64(100%)
WA	22(40.0%)	33(60.0%)	55(100%)
SA	24(68.6%)	11(31.4%)	35(100%)
ACT	2(28.6%)	5(71.4%)	7(100%)
NT	-	4(100.0%)	4(100%)
Tas	5(55.6%)	4(44.4%)	9(100%)
NZ	11(14.5%)	65(85.5%)	76(100%)
Total	200(37.0%)	340(63.0%)	540(100%)

The types of pre-operative topical antibiotics used by cataract surgeons are shown in Figure 4.3. Topical chloramphenicol (34%) was the most common antibiotic followed by quinolone antibiotics (ciprofloxacin and ofloxacin) and tobramycin.

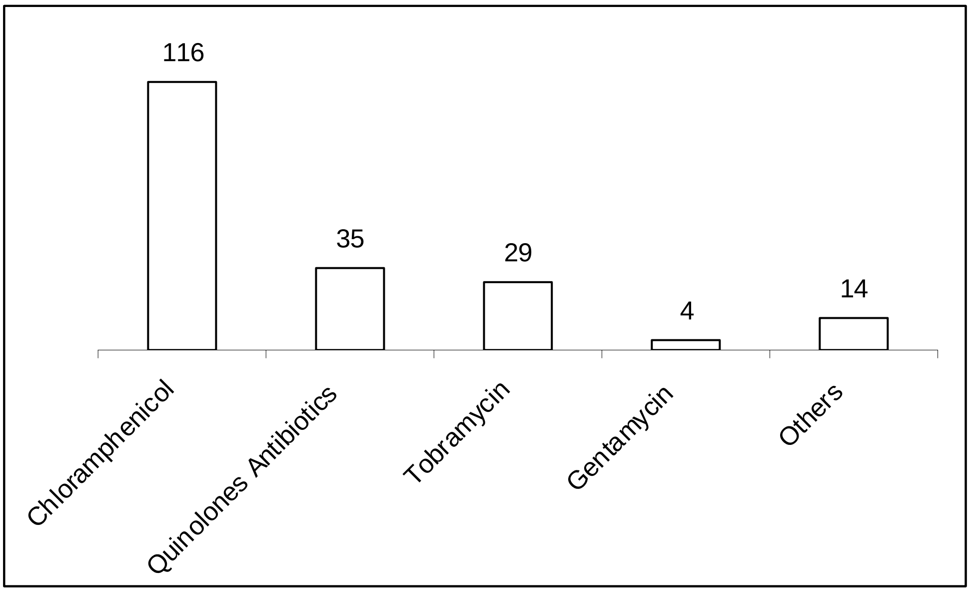


Figure 4.2 Users of pre-operative antibiotic

4.5.2 Preoperative use of antiseptics

Application of pre-operative antiseptics was the most widely used method of chemoprophylaxis with over 99% cataract surgeons using this form of prophylaxis. Table 4.11 shows the most widely used antiseptic was Povidone-Iodine which was used by 98.6% surgeons across Australia and New Zealand. Ninety five percent of cataract surgeons that used pre-operative antiseptics also applied antiseptics to the conjunctival sac before the surgery and fifty six percent of pre-operative antiseptics users left the antiseptic before wiping or flushing it from conjunctival sac.

Table 4.11 Preoperative use of antiseptics

Use of antiseptic	NSW	Vic	Qld	WA	SA	ACT	NT	Tas	NZ	Total
None	3 (1.7%)	-	-	-	-	-	-	-	-	3 (0.5%)
Povidone-Iodine	172 (97.7%)	112 (98.2%)	64 (100%)	54 (98.2%)	35 (100%)	7 (100%)	4 (100%)	9 (100%)	75 (98.7%)	532 (98.6%)
Chlorhexidine	1 (0.6%)	1 (0.9%)	-	1 (1.8%)	-	-	-	-	1 (1.3%)	4 (0.7%)
Other	-	1 (0.9%)	-	-	-	-	-	-	-	1 (0.2%)
Total	176 (100%)	114 (100%)	64 (100%)	55 (100%)	35 (100%)	7 (100%)	4 (100%)	9 (100%)	76 (100%)	540 (100%)

4.5.3 Intra-operative use of antibiotics

The majority of cataract surgeons (93%) used intra-operative antibiotics on occasions either while operating or immediately after the procedure. Figure 4.4 shows the different methods of administration of intra-operative antibiotics which included administration with irrigation fluid, intracameral injection, subconjunctival injection and topically. Subconjunctival injection was the most commonly employed method for antibiotic administration (44.1%) followed by topical antibiotics (37%). Antibiotic administration with irrigation fluid and intracameral injection of antibiotic were used by very few cataract surgeons.

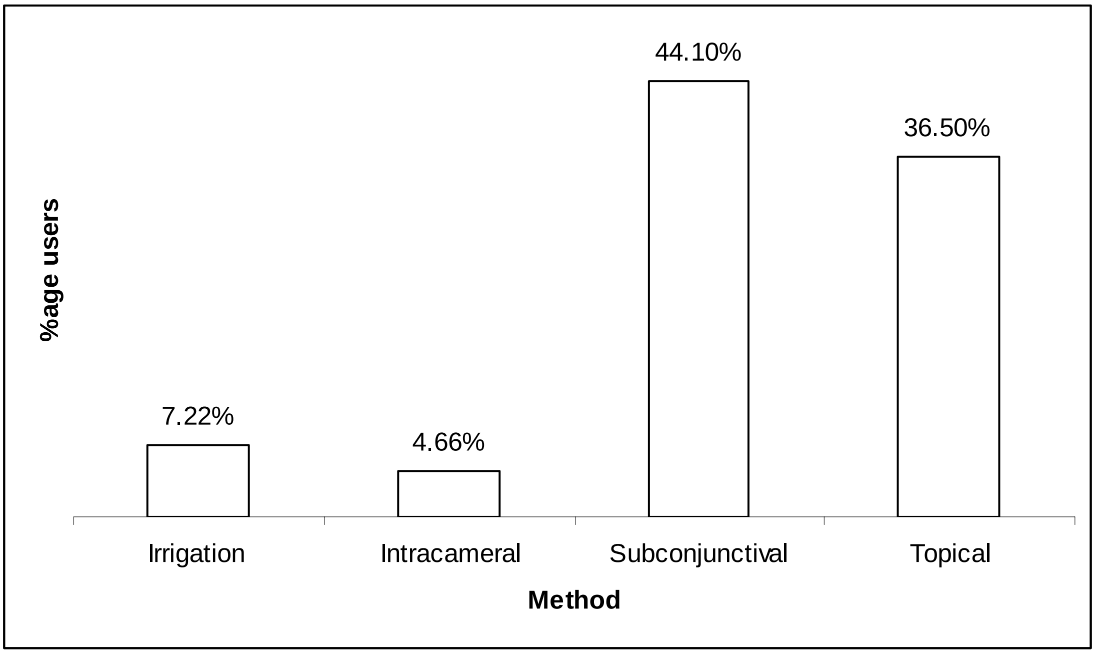


Figure 4.3 Methods for intraoperative use of antibiotics

Figure 4.5 shows the types of antibiotics used by cataract surgeons. For those cataract surgeons who used intra-operative antibiotics, the most commonly used type was aminoglycoside antibiotics, which were used by 162(33%) cataract surgeons followed by cephalosporins and chloramphenicol which were used by 146(30%) and 130(26%) cataract surgeons respectively.

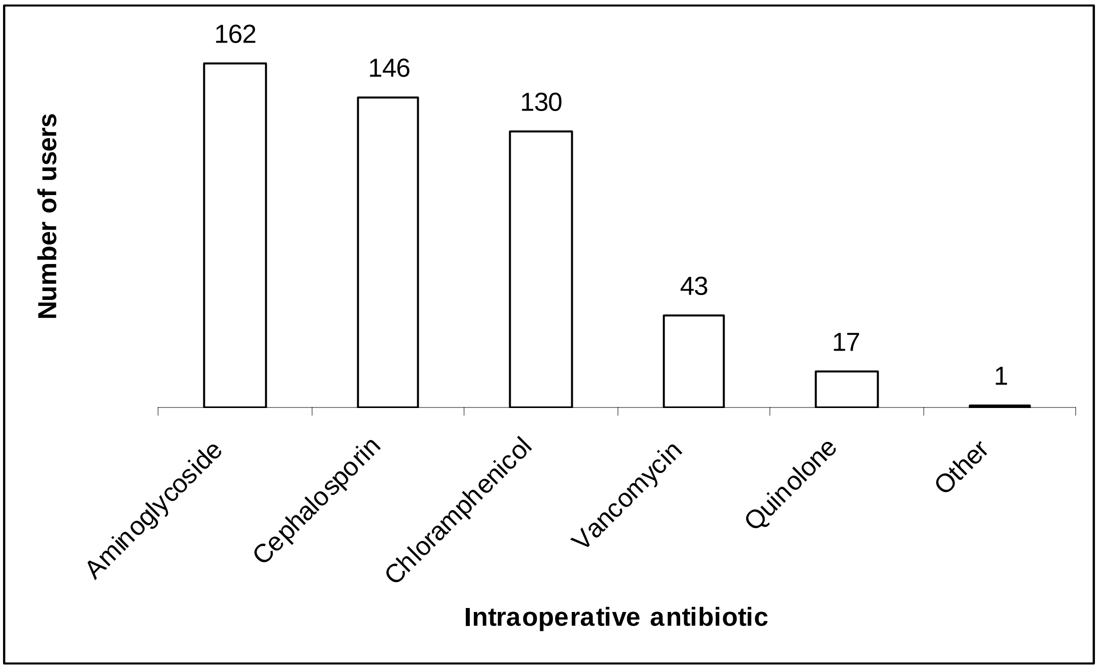


Figure 4.4 Type of intraoperative antibiotics

Table 4.12 shows the method of administration of these antibiotics. Aminoglycoside and cephalosporins antibiotics were commonly used subconjunctivally, chloramphenicol was commonly used topically. Vancomycin was used with irrigation fluid or intracameral injection.

Table 4.12 Use of intraoperative antibiotics

Antibiotic	Irrigation	Intracameral	Subconjunctival	Topical	Total
Aminoglycoside	15(9.3%)	-	101(62.3%)	46(28.4%)	162(100%)
Cephalosporin	5(3.4%)	2(1.4%)	135(92.5%)	4(2.7%)	146(100%)
Chloramphenicol	-	-	-	130(100%)	130(100%)
Vancomycin	18(41.9%)	23(53.5%)	2(4.6%)	-	43(100%)
Quinolones	-	-	-	17(100%)	17(100%)
Other	1(100%)	-	-	-	1(100%)

4.5.4 Use of post-operative subconjunctival steroid

Table 4.13 shows post-operative use of subconjunctival steroids. Overall subconjunctival steroids were used by 42% of cataract surgeons with dexamethasone was the most commonly used steroid (87%).

Table 4.13 Use of subconjunctival steroid

Sub-conjunctival steroid	NSW	Vic	Qld	WA	SA	ACT	NT	Tas	NZ	Total
Non-users	95 (53.9%)	62 (54.4%)	42 (65.6%)	36 (65.5%)	22 (62.8%)	3 (42.9%)	3 (75.0%)	9 (100%)	40 (52.6%)	312 (57.8%)
Dexamethasone	60 (34.1%)	51 (44.7%)	19 (29.6%)	16 (29.1%)	12 (34.3%)	4 (57.1%)	1 (25.0%)	-	36 (47.4%)	199 (36.8%)
Betamethasone	19 (10.8%)	-	2 (3.2%)	1 (1.8%)	-	-	-	-	-	22 (4.1%)
Prednisolone	1 (0.6%)	1 (0.9%)	1 (1.6%)	2 (3.6%)	1 (2.9%)	-	-	-	-	6 (1.1%)
Other	1 (0.6%)	-	-	-	-	-	-	-	-	1 (0.2%)
Total	176 (100%)	114 (100%)	64 (100%)	55 (100%)	35 (100%)	7 (100%)	4 (100%)	9 (100%)	76 (100%)	540 (100%)

4.5.5 Use of post-operative topical antibiotics

In Table 4.14 ninety seven percent of participating cataract surgeons used topical antibiotics after cataract surgery. This was the second most widely used method of chemoprophylaxis. The most widely used topical antibiotic after cataract surgery was chloramphenicol, which was used by 70% of cataract surgeons, followed by aminoglycoside antibiotics (tobramycin, gentamycin, and neomycin) then quinolone antibiotics (ofloxacin and ciprofloxacin).

In New Zealand, 71% cataract surgeons used neomycin alone or in combination with steroid and polymyxin (Maxitrol®-fixed dose combination). Neomycin is currently not available in Australia under the Pharmaceutical Benefit Scheme. Of the cataract surgeons in Australia 70% used chloramphenicol as post-operative topical antibiotic.

Table 4.14 Use of postoperative topical antibiotics

Use of topical antibiotics	NSW	Vic	Qld	WA	SA	ACT	NT	Tas	NZ	Total
Non-users	4 (2.3%)	-	4 (6.2%)	3 (5.5%)	1 (2.9%)	-	-	-	2 (2.6%)	14 (2.6%)
Chloramphenicol	121 (68.7%)	102 (89.5%)	35 (54.7%)	35 (63.6%)	20 (57.1%)	5 (71.4%)	4 (100%)	4 (44.5%)	14 (18.5%)	340 (62.9%)
Aminoglycoside	24 (13.6%)	10 (8.8%)	15 (23.5%)	13 (23.6%)	14 (40.1%)	1 (14.3%)	-	3 (33.3%)	3 (3.9%)	83 (15.4%)
Quinolones	23 (13.1%)	2 (1.7%)	8 (12.5%)	3 (5.5%)	-	1 (14.3%)	-	1 (11.1%)	1 (1.3%)	39 (7.2%)
Other	4 (2.3%)	-	2 (3.1%)	1 (1.8%)	-	-	-	1 (11.1%)	2 (2.6%)	10 (1.9%)
Neomycin	-	-	-	-	-	-	-	-	54 (71.1%)	54 (10.0%)
Total	176 (100%)	114 (100%)	64 (100%)	55 (100%)	35 (100%)	7 (100%)	4 (100%)	9 (100%)	76 (100%)	540 (100%)

4.6 Risk factors for Post-operative endophthalmitis

4.6.1 Demographic Factors

Multivariate Poisson regression analysis was conducted to identify the various relative risks by demographic factor for postoperative endophthalmitis after cataract surgery (Table 4.15).

While the incidence rate ratio of endophthalmitis was higher for female cataract surgeons than males, this difference was not statistically significant. Also no statistically significant differences were found in the incidence risk ratio by experience or age of surgeon. However, practice location was found to be statistically significant risk factor. Compared with Victoria, practice locations with statistically higher incidence risk ratios were the Northern Territory (IRR-14.78), the Australian Capital Territory (IRR-7.50), Queensland (IRR-3.00) and New South Wales (IRR-2.39).

Table 4.15 Incidence rate ratios by demographic factors of cataract surgeons

	Incidence rate ratio*	95% confidence interval	p-value
Surgeon's gender			
Male	1.00		
Female	1.84	0.98–3.45	0.06
Duration as a specialist			
Trainee	0.72	0.19–2.77	0.64
≤ 2 years	1.01	0.29–3.55	0.99
> 2 years	1.00		
Surgeon's age			
< 35 years	1.91	0.55–6.58	0.31
35–60 years	1.00		
> 60 years	0.51	0.20–1.28	0.15
Practice location			
Victoria	1.00		
New South Wales	2.39	1.14–5.01	0.02
Australian Capital Territory	7.50	1.92–29.29	0.00
Queensland	3.00	1.24–7.25	0.02
South Australia	1.69	0.56–5.17	0.36
Western Australia	2.20	0.89–5.42	0.09
Northern Territory	14.78	4.42–49.41	<0.001
Tasmania	1.69	0.39–7.28	0.48
New Zealand	1.85	0.71–4.81	0.21
*Incidence risk ratio adjusted for all factors in Tables 4.15, 4.16, 4.17			

4.6.2 Cataract surgery techniques

Multivariate poisson regression analysis was conducted to identify the various relative risks by surgery technique for post-operative endophthalmitis following cataract surgery (Table 4.16).

The location of the cataract surgery incision was found to be a risk factor for postoperative endophthalmitis. Temporal incision (IRR 0.53, 95% CI 0.31- 0.88, P-value 0.02) reduced the risk of postoperative endophthalmitis to almost half in comparison to superior incision. On the other hand, the use of corneal or limbal incisions (IRR 4.89, 95% CI 1.15–20.72) was associated with an increased incidence of endophthalmitis compared with the use of the scleral incisions.

Table 4.16 Incidence rate ratios by cataract technique

	Incidence rate ratio*	95% confidence interval	p-value
Cataract surgery wound approach			
Superior	1.00		
Temporal	0.53	0.31–0.88	0.02
Other	0.50	0.21–1.17	0.11
Cataract surgery wound location			
Scleral	1.00		
Corneal or limbal	4.89	1.15–20.72	0.03
Suturing of cataract surgery wound			
No	1.00		
Yes	1.45	0.51–4.12	0.49
*Incidence risk ratio adjusted for all factors in Tables 4.15, 4.16, 4.17			

4.6.3 Use of chemoprophylaxis

Multivariate Poisson regression analysis was conducted to identify the various relative risks by type of chemoprophylaxis for post-operative endophthalmitis following cataract surgery (Table 4.17).

The use of any type of subconjunctival antibiotic halved the rate of postoperative endophthalmitis (IRR 0.53, 95% CI 0.30–0.92). None of the other forms of chemoprophylaxis were associated with a significant reduction in endophthalmitis incidence. Only three respondents did not routinely use preoperative antiseptic so it was not possible to examine risk of non-use in the model. The routine use of preoperative conjunctival sac antiseptic was less common and was included in the model but found to be an insignificant factor.

Table 4.17 Incidence rate ratio by type of chemoprophylaxis

	Incidence rate ratio*	95% confidence interval	p-value
Chemoprophylaxis for cataract surgery§			
Preoperative topical antibiotic	0.74	0.45–1.23	0.25
Preoperative conjunctival sac antiseptic	2.54	0.33–19.42	0.37
Irrigation fluid antibiotics	0.98	0.87–1.09	0.66
Intracameral antibiotic	0.86	0.35–2.11	0.75
Subconjunctival antibiotic	0.53	0.30–0.92	0.03
Perioperative topical antibiotic	1.38	0.85–2.23	0.19
Postoperative conjunctival sac antiseptic	0.68	0.39–1.18	0.17
Postoperative topical antibiotic	1.49	0.20–11.27	0.70

§ The result for each type of chemoprophylaxis is in comparison to the non-use of that particular type of chemoprophylaxis.
*Incidence risk ratio adjusted for all factors in Tables 4.15, 4.16, 4.17

4.7 Management of Endophthalmitis

This section presents the data collected from the medical records of patients who were treated for post-operative endophthalmitis after cataract surgery in four metropolitan hospitals. Of the 46(75.4%) patients for whom medical records were available, these patients were aged between 17 and 91, with three patients aged less than 50 years, seven aged between 60 and 69 years, 20 were between 70 and 79 years, 15 were between 80 and 89 and one patient was aged more then 90 years. Twenty six of the patients were female while twenty were male.

4.7.1 Length of stay

The total number of days spent in hospital by the 49 patients who were treated for post-operative endophthalmitis after cataract surgery were 320 days with the range between 0 to 23 days (Table 4.18). The average length of stay was 6.5 days, this varied from 3.7 days to 7.6 days.

Differences in the average length of stay of patients across the four hospitals were analysed using the non-parametric Kurskal-Wallis test, since the data was not normally distributed. The average length of stay at the four hospitals were found not to be statistically significantly different (p = 0.367).

Table 4.18 Length of stay

Length of stay	Hosp A	Hosp B	Hosp C	Hosp D	Total
Total LOS	159	91	59	11	320
Total patients	25	12	9	3	49
LOS/Patient	6.36	7.58	6.55	3.66	6.53

4.7.2 Vitrectomy

Table 4.19 shows that vitrectomy was performed in 80.4% (37) of cases, being treated for post-operative endophthalmitis. The percentage of vitrectomy procedures carried out among the post-operative endophthalmitis cases in the four hospitals were not significantly different (p = 0.886).

Table 4.19 Use of vitrectomy for post-operative endophthalmitis

	Hosp A	Hosp B	Hosp C	Hosp D	Total
Vitrectomy	21(84%)	7 (77.8%)	7 (77.8%)	2 (66.7%)	37(80.4%)
No-vitrectomy	4 (16%)	2 (22.2%)	2 (22.2%)	1 (33.3%)	9(19.4%)

4.7.3 Use of intravitreal antibiotics

Table 4.20 shows the use of intravitreal antibiotics for the management of post-operative endophthalmitis. Intravitreal antibiotics were used in all the cases for the management of postoperative endophthalmitis. Usually a combination of intravitreal antibiotics was used, the most commonly used combination was "vancomycin + gentamycin" used in 67% (n=31) of cases, followed by "vancomycin + ceftazidime" used in 24% (n=11) of cases. "vancomycin + amikacin" and vancomycin alone were used in two cases. vancomycin + gentamycin combination was preferred in all the hospitals except for Hospital C where vancomycin + ceftazidime combination was used in 89% (n=8) cases.

Table 4.20 Use of intravitreal antibiotics for post-operative endophthalmitis

Antibiotic used	Hosp A	Hosp B	Hosp C	Hosp D	Total
vancomycin+ gentamycin	23(92%)	6(66.7%)	1(11.1%)	1(33.3%)	31(67.5%)
vancomycin+ ceftazidime	-	1(11.1%)	8(88.9%)	2(66.7%)	11(23.9%)
vancomycin+ amikacin	-	2(22.2%)	-	-	2(4.3%)
vancomycin	2(8%)	-	-	-	2(4.3%)

Table 4.21 summarizes the use of antibiotics over several years. During 1997 and 1998, vancomycin+ gentamycin was the only combination of antibiotics used for management of postoperative endophthalmitis but other antibiotics have been used since 1999 including vancomycin+ ceftazidime and vancomycin on its own.

Table 4.21 Trend in use of intravitreal antibiotics

Antibiotic	1997	1998	1999	2000
vancomycin+ gentamycin	12(100%)	11(100%)	2(33.3%)	6(35.4%)
vancomycin+ ceftazidime	-	-	2(33.3%)	9(52.9%)
vancomycin+ amikacin	-	-	-	2(11.2%)
vancomycin	-	-	2(33.3%)	-

4.7.4 Diagnosis of Postoperative endophthalmitis

Anterior and vitreous fluid specimens were used in diagnosis of all the cases except one. In 59% (n=27) two specimens were cultured, in 26% (n=12) of cases only one specimen was cultured while in 12% (n=6) of cases, cultures were performed with three or more specimens.

Urea and electrolytes (U&E) were measured in 54% (n=25) of cases and repeated in 7% (n=3) of cases. Full blood picture was carried out in 59% (n=27) of cases, with the test repeated two or more times in 11% (n=5) of cases. Electro Cardiogram (ECG) was done in 39% (n=18) of cases while ultrasound of the eye was done in 7% (n=3) of the cases only.

4.7.5 Post treatment out-patient department visits

Table 4.22 shows the number of out-patient hospital visits after patients were discharged from hospital. Sixteen percent (n=8) of the cases had no recorded OPD visits after discharge from hospital, 54% had between one and three OPD visits and 30% had four or more visits

Table 4.22 Number of out-patient visits

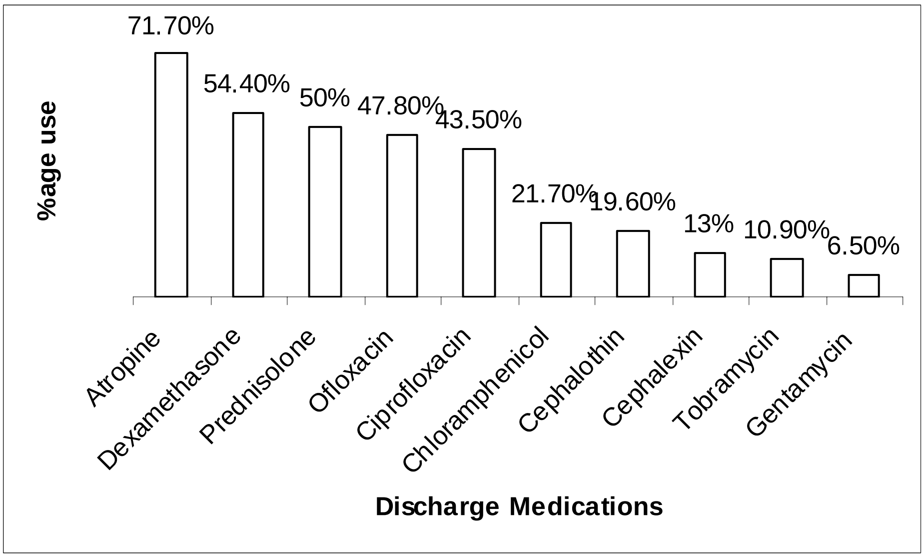
Number of visits	None	1	2	3	4	5	6	7	8	9	10	>10
Number of patients	8	13	7	7	3	3	1	2	2	0	0	4
%age of patients	16	26	14	14	6	6	2	4	4	0	0	8

4.7.6 Discharge medications

Figure 4.6 shows the commonly prescribed medications for the patients treated for post-operative endophthalmitis. Atropine was the most commonly prescribed medication and given in 72% (n=33) of cases. It was followed by anti-inflammatory topical steroids like dexamethasone prescribed in 54% (n=25) of cases and prednisolone in 50% (n=23) of cases respectively. Among the antibiotics, quinolones were the most commonly used, with ofloxacin and ciprofloxacin being used in 48% and 44% of cases respectively, followed by cephalosporins, chloramphenicol and aminoglycoside antibiotics.

In 72% (n=33) of cases discharge medications were prescribed for a period of one week or less. In remainder of cases medications were prescribed for ten or more days.

Figure 4.5 Medications on discharge



4.8 Cost of management of post-operative endophthalmitis

4.8.1 In-hospital cost of management of post-operative endophthalmitis

The hospital costs of management were obtained from the accounts/business departments of the respective hospitals where those cases were treated. These costs were calculated on the basis of Australian Diagnosis Related Groups (AR-DRGs), with some costs directly allocated to individual patients and other allocated more generally, based on various allocation algorithms. Since these cases were treated between the periods of 1997-2000, all the costs were adjusted to 2005 prices using an appropriate price index.

Since different numbers of cases were treated in these hospitals and cost information was not available for all the patients only those cases were used where cost information was available from the respective hospitals. The average cost of treatment of endophthalmitis varied across the hospitals.

The average in-hospital cost of treatment of endophthalmitis was $6,560. The cost of management of endophthalmitis in Hospital C was significantly higher than other hospitals while this cost in hospital D was considerably less than other hospitals.

Table 4.23 Hospital cost of treating patients with endophthalmitis

Cost and length of stay	Hosp A	Hosp B	Hosp C	Hosp D	Total
Number of incidences of post-operative endophthalmitis	31	7	9	3	50
Total length of stay	206	36	59	11	312
Hospital cost($)	209,099	42,457	67,630	8,828	328,015
Average hospital cost per episode($)	6,745	6,065	7,514	2,943	6,560

Break-down of in-hospital costs

The in-hospitals cost were broken down according to DRG pattern. The main cost breakdowns were ward medical, ward nursing, operative costs and cost of prosthetic devices, pathology and imaging, pharmacy, hotel, ward supplies, medical services, emergency, allied health and depreciation. The three public hospitals used this cost break-down system while the private hospital used a simpler cost break-down system and only split the cost into accommodation, surgery and pharmacy cost. Table 4.24 shows these cost break down in public hospitals and Table 4.25 shows hospital cost break down in private hospital. The costs varied among all the hospitals, ward medical, nursing and operative costs per case were highest in ‘Hospital A’ while pharmacy cost per case was highest in ‘Hospital C’. Accommodation cost per case was highest in ‘Hospital D’; while among the public hospitals it was highest in ‘Hospital B’. Depreciation cost was the highest in ‘Hospital B’.

Table 4.24 Hospital cost breakdown

	Hospital A		Hospital B		Hospital C	
Cost	Hospital cost for 19 patients ($)	Hospital cost per patient ($)	Hospital cost for 7 patients ($)	Hospital cost per patient ($)	Hospital cost for 9 patients ($)	Hospital cost per patient ($)
Ward Medical	36,468	1,919	8,227	1,175	15,336	1,704
Ward nursing	35,510	1,869	4,922	703	10,051	1,116
Operative	20,277	1,067	5,763	819	7,568	840
Pathology & imaging	3,836	202	432	62	1,249	139
Pharmacy	1,946	102	341	49	2,084	231
Hotel	4,418	232	8,780	1,254	4,503	500
Ward supplies	2,380	125	4,209	601	6,823	758
Emergency	1,405	74	539	77	53	5.8
Allied health	885	46	-	-	1,729	192
Depreciation	1,412	74	812	116	613	68

Table 4.25 Hospital cost breakdown 'Hospital D'

Hospital D	Accommodation	Operative	Pharmacy
Hospital cost for 3 patients ($)	5,100	1,665	376
Hospital cost per patient ($)	1,700	555	125

4.8.2 Cost of out-patient department visits

Out-patient department visits were valued using costs collected in the national Hospital Cost Data Collection that was undertaken by the Commonwealth Department of Health and Ageing. The cost of an outpatient visit to ophthalmology clinic was estimated as $92. The average cost per patient for outpatient visits varied from $153 to $439 (Table 4.26)

Table 4.26 Out-patient department visit

OPD visits	Hosp A	Hosp B	Hosp C	Hosp D	Total
Total number of OPD visits	84	40	43	5	172
Maximum number of visits by a patient	14	19	17	3	-
Minimum number of visits by a patient	0	0	0	1	-
Average visit per patient	2.8	5.7	4.7	1.6	3.7
Total cost of OPD visits ($)	7,728	3,680	3,956	460	15,824
OPD visit cost per patient ($)	297	408	439	153	344

4.8.3 Total cost of management of post-operative endophthalmitis

The total cost of management of post-operative endophthalmitis was calculated by adding the in-hospital cost of treatment of endophthalmitis and the cost of out-patient department visits by patients, once they were discharged from the hospital. The average total cost of management of post-operative endophthalmitis was used for the cost analysis in the following section. The total cost of management of post-operative endophthalmitis for different hospitals are given in Table 4.27

Table 4.27 Total cost of management of post-operative endophthalmitis

Cost	Hosp 'A'	Hosp 'B'	Hosp 'C'	Hosp 'D'	Total
In-hospital cost ($)	209,099	42457	67630	8828	328,014
OPD visit cost ($)	7,728	3,680	3,956	460	15,824
Total ($)	216,827	46,137	71,586	9288	343,838
Average cost per case ($)	6,994	6,591	7,954	3,096	6,876

4.9 Cost analysis of chemoprophylaxis for cataract surgery

4.9.1 Approach to costing

This section examines selected cost aspects relating to the use of chemoprophylaxis to reduce the incidence of post-operative endophthalmitis. The multivariate regression analysis showed that the only type of chemoprophylaxis technique that showed significant risk reduction for post-operative endophthalmitis was the use of subconjunctival antibiotics which reduced risk by approximately 50% (Section 4.6.3). The survey of cataract surgeons found that only 44% used subconjunctival chemoprophylaxis during cataract surgery

A base case analysis was conducted to determine the net costs to the health system if all cataract surgeons were to use subconjunctival chemoprophylaxis. The analysis involved calculating (i) the costs associated with additional use of subconjunctival antibiotics if those cataract surgeons who reported not using subconjunctival chemoprophylaxis used it and (ii) the cost saving that would result from the associated risk reduction for post-operative endophthalmitis. Since gentamycin was the most commonly used subconjunctival antibiotic in Western Australia (Section 4.5.3), the cost analysis was conducted assuming these surgeons used gentamycin subconjunctivally in all the cataract procedures they performed.

The cost of subconjunctival gentamycin per case was obtained from one of the hospital pharmacies. The cost of subconjunctival gentamycin injection included the cost of the antibiotic and the cost of the syringe and needles. Since in normal practice this injection is prepared in operating theatre by the surgeon before the administration, no pharmacy dispensing charges were included. The cost break down for a gentamycin injection is as given in Table 4.28.

Table 4.28 Cost of subconjunctival gentamycin injection

Item description	Cost($)
Cost of gentamycin per injection	0.78
Cost of syringe(1ml or 3ml)	0.10
Cost of two needles	0.10
Total cost of injection	0.98

In addiction to the base case analysis, a break even analysis and sensitivity analysis of the use of subconjunctival chemoprophylaxis were conducted. These are discussed following the description of the base cost analysis.

4.9.2 Base case analysis

Two scenarios were considered in the base case analysis. In scenario 'A' no subconjunctival antibiotics were used as chemoprophylaxis by the cataract surgeons who reported not using it in the survey, while in scenario 'B' it was assumed that subconjunctival gentamycin was used as chemoprophylaxis by these surgeons in all cataract procedures they performed. The use of subconjunctival antibiotic has been shown to be associated with a risk reduction of 0.53 for post-operative endophthalmitis, which implies there would have been thirty fewer cases of post-operative endophthalmitis if subconjunctival chemoprophylaxis had been used in all cataract procedures.

The base case analysis was performed, as shown in Table 4.29. The number of cataract procedures and cases of post-operative endophthalmitis in each scenario were valued using the average cost of hospitalization (section 4.8.3) and cost of gentamycin injection used for chemoprophylaxis. The additional cost of subconjunctival gentamycin if all cataract surgeons had used it was \$95,926. The cost saving from fewer cases of post-operative endophthalmitis was \$233,784. The net costs were calculated by subtracting the difference in total cost of scenario 'A' from those of scenario 'B'. The results of the base case analysis suggest that if the use of subconjunctival chemoprophylaxis in all cataract procedures by those cataract surgeons who reported not using it would have led to net cost savings to the health system of \$110,354.

Table 4.29 Base case analysis of increasing the use of subconjunctival chemoprophylaxis

Scenario	Scenario 'A'	Scenario 'B'
Number of cataract procedures reported	97,884	97,884
Reported number of case of post-operative endophthalmitis	64	34
Cost of treating reported number of cases of post-operative endophthalmitis ($)	440,064	233,784
Cost of subconjunctival Gentamycin prophylaxis ($)	0	95,926
Total cost of endophthalmitis	440,064	329,710
Cost saving with use of subconjunctival antibiotics = $110,354		

4.9.3 Break even analysis

The break even analysis calculated the number of cases of post-operative endophthalmitis that would have to be prevented so that the additional costs associated with the use of subconjunctival gentamycin by the all the cataract surgeons who reported not using it were exactly offset by the cost savings from the risk reduction from post-operative endophthalmitis.

The total cost of subconjunctival gentamycin chemoprophylaxis for the 97,884 procedures performed by the cataract surgeons who reported not using it was $95,926. The average cost of managing a single episode of endophthalmitis was $6,876. Thus in order to exactly offset the additional costs of subconjunctival gentamycin prophylaxis, 14 cases of post-operative endophthalmitis would have to be prevented. This number of cases is sometimes called the 'break even point'. A reduction by 14 cases of post-operative endophthalmitis represent 15% reduction in cases of post-operative endophthalmitis.

4.9.4 Sensitivity analysis

A sensitivity analysis was conducted to examine how sensitive the results of the base case analysis were to change in the values of selected variable. The cost of the gentamycin injection was adjusted for 100% more and less of the base price and cost of hospitalization was adjusted for the maximum and minimum reported cost of treatment of endophthalmitis obtained from the hospitals. Lower limit of gentamycin cost increased cost effectiveness ratio to 1.43 and reduced the number of cases needed to off set the cost of chemoprophylaxis to 7 cases, while the upper limit cost of gentamycin reduced the cost effectiveness ratio to 0.13.

The lower cost of treatment increased the cost effectiveness ratio to 2.16 while upper limit cost of treatment decreased cost effectiveness ratio to 0.66

Table 4.30 Sensitivity analysis

Cost of gentamycin injection			
		Sensitivity analysis	
Cost	Base case	Low limit	High limit
Cost of antibiotic prophylaxis ($)	0.98	0.49	1.96
Cost for 97884 surgeries	95,926	47,963	191,852
Total cost of endophthalmitis ($)	329,710	281,747	425,636
Cost saving ($)	110,354	158,317	14,428
Cost effectiveness ratio	-	1.43	0.13
Number of case must be prevented to off set the cost of chemoprophylaxis	14	7	28
Relative risk ratio	0.048	0.052	0.039
Hospital cost of treatment of endophthalmitis			
Hospital cost ($)	6876	3096	7954
Cost of management of 34 cases of post-operative endophthalmitis ($)	233,784	105,264	270,436
Total cost of endophthalmitis ($)	329,710	201,190	366,362
Cost savings ($)	110,354	238,874	73,702
Cost effectiveness ratio	-	2.16	0.66

4.10 Cataract surgery chemoprophylaxis- over a decade

The finding of the present survey was compared with the survey of Australian cataract surgeons conducted in 1994 by Morlet *et al*[100]. The main findings of comparison as presented in the following sections.

4.10.1 Pre-operative use of antibiotics

Table 4.31 shows the use of pre-operative antibiotics during 1994 and 2003. It was found that use of pre-operative antibiotics decreased over the decade. Chloramphenicol remained the most widely used pre-operative antibiotic although percentage users decreased. Quinolones antibiotics which were not used in 1994 were used by 6.5% cataract surgeons who responded to present survey while neomycin was no longer used by cataract surgeons. Use of aminoglycoside antibiotic did not change significantly over the decade.

Table 4.31 Pre-operative antibiotic use

Cataract surgeons	Chloramphenicol	Aminoglycoside	Quinolone	Neomycin	Other	Non user
Users 1994(%)	39.2	8.5	0.0	4.7	2.5	45.3
Users 2003(%)	21.5	6.1	6.5	0.0	2.6	63.3

4.10.2 Pre-operative use of antiseptics

Tables 4.32 and 4.33 shows the use of pre-operative antiseptics in cataract surgery. Antiseptics were still used by almost all the cataract surgeons, but the use of chlorhexidine decreased over the decade.

Table 4.32 Use of pre-operative antiseptics

Cataract surgeons	Povidone-Iodine	Chlorhexidine	Non- User
Users 1994(%)	89.5	10.5	0.0
Users 2003(%)	98.5	0.9	0.6

The application of antiseptic on the conjunctival sac increased over the decade as shown in Table 4.33. In 2003 antiseptics were applied on conjunctival sac by 94.3% cataract surgeons as against 55.8% surgeons in 1994

Table 4.33 Antiseptic use on conjunctival sac

Cataract surgeons	Users	Non- User
Users 1994(%)	55.8	44.2
Users 2003(%)	94.3	5.7

4.10.3 Use of subconjunctival antibiotics

Table 4.34 shows the use of subconjunctival antibiotics. The use of subconjunctival antibiotics declined over the decade. There was change in preference from aminoglycoside antibiotics to cephalosporins.

Table 4.34 Use of subconjunctival antibiotics

Cataract surgeons	Aminoglycoside	Cephalosporin	Chloramphenicol	Neomycin	Non-user
Users 1994(%)	68.1	3.4	0.2	0.4	27.8
Antibiotic	Aminoglycoside	Cephalosporin	Vancomycin	Neomycin	Non-user
Users 2003(%)	18.7	25.0	0.4	0.0	55.9

4.10.4 Use of post-operative topical antibiotics

Table 4.35 shows the use of post-operative topical antibiotics. The post-operative antibiotic remained the most commonly used chemoprophylaxis. The percentage users increased marginally. Chloramphenicol remained the most frequently used antibiotic, followed by aminoglycoside antibiotics. Quinolones group antibiotics which were not used a decade ago were being used by 7.2% cataract surgeons in present survey.

Table 4.35 Use of post-operative antibiotics

Cataract surgeons	Chloramphenicol	Aminoglycoside	Neomycin	Quinolones	Non-user
Users 1994(%)	67.7	24.0	4.3	0.0	4.0
Users 2004(%)	62.9	15.4	10	7.2	2.6

5 DISCUSSION

This study has examined differences in the methods of performing cataract surgery, in particular focusing on different surgical practices and chemoprophylaxis regimens and their influence on the rate of post-operative endophthalmitis. The data for the study were obtained from a survey of cataract surgeons in Australia and New Zealand. In addition to investigating current methods of performing cataract surgery, the study also compared the results of the current survey of cataract surgeons with those from a previous survey of cataract surgeons conducted over 10 years ago[100]. This enabled temporal changes in practice by local cataract surgeons to be examined, and also for local practice to be compared with international practice. A major strength of this study was the high level of participation by Australian and New Zealand cataract surgeons. This provided a comprehensive and accurate overview of contemporary cataract surgery practice in Australasia.

5.1 Incidence of post-operative endophthalmitis

The results from the survey of cataract surgeons indicate that the rates of postoperative endophthalmitis in Australia and New Zealand were comparable to previously published international rates.[17] Although the self-reported incidence rate of postoperative endophthalmitis in Australia and New Zealand at 0.056 per 1,000 was below the long-term average of 2 per 1,000, it was still within the fluctuating limits that were previously reported.[6, 12]

The incidence of postoperative endophthalmitis varied considerably across Australia and New Zealand. For regions with low surgical volumes, such as the Australian Capital Territory and the Northern Territory, the results were probably skewed by just a few extra reported cases of endophthalmitis as evidenced by the wide confidence intervals for the incidence rate ratios. A number of regions had significantly higher rates of endophthalmitis even after differences in surgical technique and chemoprophylaxis were taken into account. The observed regional differences indicate other important factors are involved with the development of endophthalmitis that were not included in the Poisson model due to the nature of the study design. Although it has been previously reported that same-day cataract surgery increased the risk of endophthalmitis,[17, 105] it is unlikely that differences in admission patterns accounted for the regional differences, as the proportion of same-day operations was broadly similar. Regional differences in weather may be a possible explanation given in previous reports of an increased risk of endophthalmitis with winter operations[17] and preoperative cumulative rainfall.[106] Such factors may be responsible for seasonal variation in conjunctival flora. To better understand the basis of these regional differences would require a common system of reporting and data collection.

5.2 Methods of chemoprophylaxis for cataract surgery

The comparison with an earlier Australian survey showed that methods of chemoprophylaxis used by Australian ophthalmologists have generally changed little over the past decade. The exception was a substantial reduction in subconjunctival antibiotic use from 72% to 44% (Table 4.34). A preoperative topical antibiotic continued to be used by around half of all ophthalmologists and chloramphenicol remained the most popular choice. There was a slight increase in the use of postoperative topical antibiotics from 96% to 97% and whilst Australian ophthalmologists still most commonly prescribe chloramphenicol, neomycin was the most popular choice in New Zealand. Preoperative antiseptic was used by almost all ophthalmologists; in keeping with the more compelling evidence in favour of its use.

Other international surveys have found varied patterns in the use of chemoprophylaxis, which reflects ongoing debate and research into the optimal methods of chemoprophylaxis (Table 5.1). The addition of antibiotics to the irrigation fluid remains seldom used in Australia, New Zealand and northern England[107] whilst it is regularly used by almost a third of ophthalmologists in the United States. Intracameral antibiotic use was low in Australia, New Zealand, northern England and the United States[108]. Meanwhile, some form of intraocular antibiotic was used by around half of the respondents to a German survey.[101] It is believed that the frequent use of intracameral antibiotics in Sweden accounts for their exceptionally low rates of postoperative endophthalmitis.[27] There is good evidence for preoperative preparation with povidone-iodine[67] and this is reflected in its wide spread use. However, it may not be the type of antiseptic that is important, but rather adequate preoperative sterilisation with an antiseptic. The rate of postoperative endophthalmitis in Sweden is low, yet povidone-iodine is not commonly used because it is not commercially available.[27]

Subconjunctival injection of antibiotics was the only form of chemoprophylaxis associated with a reduction in incidence of endophthalmitis. Although a firm conclusion that subconjunctival antibiotics are efficacious cannot be drawn from these results, these findings add to the growing body of evidence suggesting a beneficial role for subconjunctival antibiotics in the prevention of postoperative endophthalmitis.[59, 89, 105, 109] It is also interesting that the halving in incidence in the present study was similar in magnitude to that of a previously reported[105] study based on a different study population and methodology. With this increasing evidence, there may be a case to propose a prospective randomised trial but it needs to be appreciated that any such study will require a large sample size (in the order of several tens of thousands of eyes) to provide any meaningful results.

Over the past decade, the methods of chemoprophylaxis used in Australia and New Zealand have shown little change apart from a substantial decrease in the use of subconjunctival antibiotics. Routine use of subconjunctival antibiotics halved the self-reported incidence of postoperative endophthalmitis but other factors remained important due to the significant geographical variation in incidence. In general, the use of chemoprophylaxis in Australia and New Zealand is similar to England but differs substantially from the United States.

5.3 Surgical techniques for cataract surgery

Wound construction has been identified as a risk for postoperative endophthalmitis.[56, 58, 59, 105, 109] It is postulated that the increased use of temporal corneal wounds may account for the apparent increase in endophthalmitis observed in the United States.[110] The evidence for the role of wound construction in endophthalmitis remains conflicting with epidemiological and experimental studies providing the results and rationale for either increased risk[56, 58, 109] or no change in risk.[59, 105] Nonetheless, this controversy may account for the decreased use of corneal incisions by New Zealand surgeons, decreasing from 64% in 2001[111] to 14% in 2003 (Table 5.1). The results from this survey indicated that surgeons routinely using corneal or limbal incisions had an incidence of endophthalmitis 4.89 times higher than those surgeons routinely using scleral wounds. Meanwhile surgeons routinely using temporally sited wounds had almost half the incidence of endophthalmitis compared to surgeons using superior wounds. These results appear to contradict the prevailing view that temporal corneal wounds increase the risk of endophthalmitis. However, these results need to be interpreted within the context of the study's design and limitations. Although surgeons routinely using corneal incisions were at higher risk, this is not the same as corneal wounds in themselves having a higher risk. With the surgeon as the unit of observation and analysis, it can only be assumed but do not know with certainty if the cases of endophthalmitis had the same incision type as the uncomplicated operations. Another possibly important factor in the development of post-operative endophthalmitis is topical anaesthesia for cataract surgery. The aggregated regional data showed that the incidence of endophthalmitis was significantly correlated with greater routine use of topical anaesthesia (Pearson correlation coefficient 0.82, two tailed p-value 0.007) This result is consistent with Ellis' previously reported case series.[112] This may also account for the reported increase in endophthalmitis after cataract surgery in the United States[110, 113] because topical anaesthesia by survey respondents from the American Society of Cataract and Refractive Surgeons has also increased from 18% in 1996[114] to 61% in 2003.[113]Avoidance of subconjunctival antibiotic injection may be a possible explanation for the higher risk after cataract operations with topical anaesthesia.

5.4 Cost and management of post-operative endophthalmitis

Management practices for the post-operative endophthalmitis were similar in public and private hospital, although a difference in length of stay was observed but this was not significant. Vitrectomy along with intracameral antibiotics were used in the majority of cases. The cost of management of post-operative endophthalmitis varied among different hospitals. It was least in private hospital but this can be attributed to non-inclusion of indirect costs like wages of medical and non-medical staff.

With subconjunctival injection of antibiotic being the only form of chemoprophylaxis to be associated with significant reduction in the incidence of post-operative endophthalmitis, the cost implications of all cataract surgeons who reported not using this form of prophylactic treatment starting to use it was examined. After subtracting the costs of subconjunctival antibiotics from the cost savings achieved from the reduced costs of treating cases of post-operative endophthalmitis, the net cost savings to the health system if all cataract surgeons had used subconjunctival chemoprophylaxis was $110,354. A German study[101] reported an annual saving of €436,822 using gentamycin chemoprophylaxis in all its cataract procedures. Given the scarcity of health system resources, a potential net cost saving of this order of magnitude from a change in clinical practice reflects an important finding. An analysis was also conducted to ascertain the number of cases of post-operative endophthalmitis that would have to be prevented so that additional costs associated with the use of subconjunctival chemoprophylaxis by all cataract surgeons who reported not using it were exactly off set. The result of analysis suggested that 14 cases of endophthalmitis would have to be prevented in order to exactly off set the additional cost of subconjunctival chemoprophylaxis, but this number could be reduced further if indirect costs of post-operative endophthalmitis were also accounted for, along with direct hospital costs as used in the analysis.

Table 5.1 A comparison with other ophthalmologist's surveys

				Method of chemoprophylaxis						Operative technique						
	Location	Year surveyed	Respondents	Preoperative topical antibiotic	Preoperative antiseptic	Irrigation fluid antibiotic	Intracameral antibiotic	Subconjunctival antibiotic	Postoperative topical antibiotic	Topical anaesthesia	Retrobulabr anaesthetic block	Peribulbar anaesthetic block	Subtenons anaesthetic	Corneal incision	Temporal approach	Suturing of the wound
Our findings	Australia, New Zealand	2003	580	37%	99%	7%	5%	44%	97%	19%	12%	47%	17%	17%	57%	6%
Gupta *et al* (2004)[107]	Northern England	2003	103	10%	97%	5%	10%	77%	71%	-	-	-	-	-	-	-
Sekimoto *et al* (2004)[115]	Japan	2003	34	65%	-	-	-	24%	-	-	-	-	-	-	-	-
Leaming (2004)[113]	United States	2003	985	-	-	28%	10%	-	-	61%	20%	17%	2%	72%	63%	8%
Elder *et al* (2003)[111]	New Zealand	2001	70	28%	-	10%	-	63%	-	14%	12%	23%	51%	64%	44%	6%
Krummenauer *et al* (2005)[101]	Germany	2000	310	35%	-	-	58%	46%	80%	-	-	-	-	31%	-	-
Dinakaran *et al* (2002)[116]	United Kingdom	1999	346	22%	93%	8%	-	66%	64%	-	-	-	-	-	-	-
Leaming (2000)[108]	United States	1999	1,342	77%	-	32%	-	24%	-	45%	29%	24%	-	40%	49%	17%
Krootila (1999)[117]	Finland	1998	68	-	-	68%	19%	-	-	48%	2%	31%	11%	50%	44%	-

Continued next page

				Methods of chemoprophylaxis						Operative technique						
	Location	Year surveyed	Respondents	Preoperative topical antibiotic	Preoperative antiseptic	Irrigation fluid antibiotic	Intracameral antibiotic	Subconjunctival antibiotic	Postoperative topical antibiotic	Topical anaesthesia	Retrobulabr anaesthetic block	Peribulbar anaesthetic block	Subtenons anaesthetic	Corneal incision	Temporal approach	Suturing of the wound
Elder et al (2000)[118]	New Zealand	1997	72	26%	-	16%		61%	-	8%	25%	40%	24%	21%	24%	36%
Schmitz (1999)[32]	Germany	1996	311	90%	-	54%	6%	52%	-	-	-	-	-	16%	-	-
Oshika et al (1998)[119]	Japan	1996	440	-	-	-	-	-	-	22%	30%	6%	38%	15%	-	47%
Hansen (1997)[120]	Denmark	1996	91	-	-	-	-	78%	-	2%	48%	43%	6%	13%	5%	53%
Leaming (1997)[114]	United States	1996	1,440	80%	97%	41%	-	44%	96%	18%	45%	34%	-	23%	23%	33%
Morlet et al (1998)[100]	Australia	1992	450	42%	100%	8%	-	75%	95%	-	-	-	-	-	-	-

6 LIMITATIONS OF STUDY

The limitations of the study are listed below:

Survey-based studies have the potential for bias and the problems inherent with results based on aggregated measures. Although the response rate to the survey of cataract surgeons was good, it is possible that non-respondents to the survey may have had substantially different outcomes and practices to the ophthalmologists that did participate.

The survey relied on the recall by cataract surgeons in reporting their methods of surgery and chemoprophylaxis practice. Recall bias was thus a possible source of reporting error.

Survey had potential for under-reporting of incidence of post-operative endophthalmitis by the cataract surgeons, as some surgeons might view post-operative endophthalmitis as being associated with poor surgical skills and therefore might not admit to their own cases.

The analysis of factors associated with endophthalmitis was based on comparing the different rates of endophthalmitis between individual ophthalmologists and their routine clinical practice. The role of specific variation for an individual ophthalmologist (for example, the routine use of subconjunctival antibiotics for all operations except the one operation that resulted in endophthalmitis) could not be considered in this study.

The costs of management of post-operative endophthalmitis were obtained from the hospital in the Perth metropolitan area and these costs may vary in other jurisdictions. The cost of subconjunctival chemoprophylaxis was obtained from a single hospital and it was assumed that the antibiotic injection was prepared in the operating theatre by cataract surgeons and hence no pharmacy dispensing costs were considered. Inclusion of pharmacy dispensing cost would have substantially added to the cost of subconjunctival chemoprophylaxis.

7 CONCLUSIONS

In examining surgical methods and chemoprophylactic practices associated with cataract surgery across Australian states and territories and New Zealand, this study found regional variations in the surgical techniques and chemoprophylaxis practices. A comparison of these results with an earlier study suggested a decrease in the use of pre-operative antibiotics, an increase in the application of antiseptic on the conjunctival sac, and a decline in the use of subconjunctival antibiotics. The main risk factor identified for post-operative endophthalmitis included limbal or corneal incision which increased the relative risk for post-operative endophthalmitis, while temporal incision and use of subconjunctival antibiotics were associated with reduced risk for post-operative endophthalmitis. Opportunities to reduce levels of post-operative endophthalmitis will result in cost savings to the health system. For example, if all the cataract surgeons who participated in the survey of ophthalmologists converted to use of subconjunctival gentamycin, then the reduction in number of cases of post-operative endophthalmitis from 64 to 34 would result in estimated annual cost savings to the health system of $110,354.

This study was based on self-reported clinical practices of cataract surgeons and their estimates of the number of cases of post-operative endophthalmitis. A randomised double blinded clinical trail would be needed to establish the true efficacy of subconjunctival antibiotics in preventing cases of post-operative endophthalmitis. Considering the relatively small incidence rate of post-operative endophthalmitis, a large study population would be required for such a trial. However, the importance of prophylactic use of antibiotic in cataract surgery cannot be underestimated, particularly when the possible catastrophic consequences of post-operative endophthalmitis are taken into account.

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APPENDICES

Ethic committee approval letter

THE UNIVERSITY OF WESTERN AUSTRALIA

Research Ethics
Research Services
M459

35 Stirling Highway, Crawley, WA 6009
Telephone: (08) 9380 3703
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Our Ref: RA/4/3/0370

28 April 2004

Dr J Ng
School of Population Health - M431
UWA

Project: A survey of cataract surgery practice and postoperative endophthalmitis amongst Australian and New Zealand Ophthalmologists

Please be advised that ethical approval of the above project has been granted in accordance with the procedures of the Human Research Ethics Committee at the University of Western Australia.

It is the responsibility of the researcher to advise the Committee of any departure from the original protocol. The Committee requires that all Chief Investigators report **immediately** any adverse or unexpected events that might affect ethical approval of the project.

Approval should be sought in writing **in advance** from the Human Research Ethics Committee if any change to the procedures or the number of participants in the original application is envisaged. Should this change require amendments to an Information Sheet or Consent Form related to the project; the amended version of the forms should be submitted for review. The application for the amendment should give the rationale behind and justification for the amendment. You are also required to inform the Committee, giving reasons, if the research project is discontinued before the expected date of completion. Correspondence should be submitted to the Secretary, Human Research Ethics Committee, Research Services.

The Committee is bound by NHMRC Guidelines to monitor the progress of all approved projects until completion to ensure that they continue to conform to approved ethical standards. An Annual Report form will be sent to you twelve months after the initial approval date.

Please note that approval has been granted for a period of four years. Initial approval is for a period of one year, and, thereafter for future periods of one year at a time subject to the receipt of satisfactory annual reports. At the end of the four-year period you will be required to complete a new "*Application to Undertake Research Involving Human Subjects*" should you wish to continue with your research. However, in special circumstances, the Chair has the authority to extend the approval period in order to complete a project.

Please quote Project No 0370 on all correspondence associated with this study.

Yours sincerely

KATE KIRK
Administrative Officer
(Human Research Ethics Committee)

cc: Head of Department

SUB-COMMITTEE APROVAL LETTER

Confidentiality of Health Information Committee (CHIC) approval letter

CONFIDENTIALITY OF HEALTH INFORMATION COMMITTEE (CHIC)
An Independent Committee appointed by the Minister for Health in Western Australia

Please address all correspondence to:-
Project Officer - CHIC
Health Information Centre
1st Floor "C" Block
189 Royal Street
EAST PERTH WA 6004

ph: (08) 9222 4194
fax: (08) 9222 4236

Dr James Semmens
School of Population Health
University of Western Australia
35 Stirling Hwy
Crawley WA 6009

Dear Dr Semmens

#200338 **Endophthalmitis and the complications of cataract surgery in Western Australia (1980 – 2004)**

Date of commencement	01/01/2004
Date of completion	31/12/2007
Researchers accessing identifiable data	Dr James Semmens, Dr Nigel Morlet, Dr Jonathon Ng
Databases to be accessed	Hospital Morbidity Data Ssystem
Ethics approval	UWA dated 03/12/03 & RPH dated 21/05/2002

Thank you for your letter dated 06/01/2004. The Confidentiality of Health Information Committee (CHIC) reviewed your response at the meeting held 11/02/2004, and are satisfied that you have addressed their concerns about this project expressed in their letter dated 15/12/2003.

In light of the above, final approval is granted for you to proceed with your project subject to and conditional upon compliance with the following points:

- It is the responsibility of the researcher(s) to advise CHIC of any change to the above information or to the design protocol. Major changes to protocol that affect access to and use of data from the Department of Health datasets must be approved by CHIC.
- CHIC has a mandate to monitor the use of any data released for access. Monitoring includes the submission of an annual progress report, and a final report required at the completion of the project. Failure to submit reports may result in termination of access to data.
- CHIC reserves the right to monitor the progress of a project more intensively, as it sees fit. This monitoring may include site visits, interviews or documentation checks.

We wish you well with your project.

Yours sincerely

Dr David Blackledge
CHAIRPERSON

for Ms Alison Daly
DIRECTOR GENERAL'S REPRESENTATIVE

CONFIDENTIALITY OF HEALTH INFORMATION COMMITTEE

16 February 2004

Survey questionnaire for ophthalmologist

The University of Western Australia | Faculty of Medicine and Dentistry | School of Population Health
Western Australian Safety and Quality of Surgical Care Project

A Survey of Cataract Surgery Practice and Endophthalmitis amongst Australian and New Zealand Ophthalmologists

Thankyou for participating in this survey. Any information you provide will be kept anonymous and remain confidential. Please answer the questions by circling the appropriate answer and/ or entering the relevant information. All questions relate to the calendar year 2003. Even if you were not operating during 2003 please just answer the questions in the "Surgeon Demographics" section. Please return the completed questionnaire in the enclosed reply-paid envelope.

SURGEON DEMOGRAPHICS

Question 1. What is your gender?
(a) Male (b) Female

Question 2. What is your age? (at 1st January 2004) ________ years

Question 3. Where do you practise the majority of time?
(a) New South Wales (b) Victoria (c) Australian Capital Territory
(d) Queensland (e) South Australia (f) Western Australia
(g) Northern Territory (h) Tasmania (i) New Zealand

Question 4. Are you currently an ophthalmology trainee?
(a) No (b) Yes --> Go to question 9

Question 5. How long have you been a specialist ophthalmologist? (at 1st January 2004) ______ years

Question 6. Which locality do you practise?
(a) Metropolitan only (b) Rural only
(c) Metropolitan and rural. What % of time is spent in metropolitan? __________ %

Question 7. Of your patients undergoing cataract surgery, are they:
(a) All private patients (b) All public patients
(c) Both private and public. What % are private? __________ %

Question 8. Which is your dominant hand?
(a) Right (b) Left (c) Neither

SURGICAL WORKLOAD / ENDOPHTHALMITIS CASES

Question 9. During 2003, how many cataract operations did you perform on average each month?
(if you did less than 12 operations during the year then state "occasional")

____

Question 10. How many cases of endophthalmitis occurred in your own patients after cataract surgery during 2003? (if any please provide clinical details on page 4)

____

Question 11. Where do you perform cataract surgery?
(If you use more than one type of facility, record the % of procedures performed at each one)

(a) Public teaching hospital %
(b) Public non-teaching hospital %
(c) Private hospital %
(d) Private day surgery facility ______ %
100 %

Question 12. What percentage of your cataract surgery patients are:

(a) In-patients %
(b) Day-only patients ______ %
100 %

Question 13. Which of the following groups of patients would you routinely admit as an in-patient for cataract surgery? (circle all that apply)

(a) Patients living alone (b) Older patients. Specify age cutoff: ____________
(c) Patients that request admission
(d) Other. Please specify reason(s): ______________________________
(e) None

Question 14. Are any routinely admitted as in-patients before the day of cataract surgery?

(a) No (b) Yes. For how many days beforehand? __________

Question 15. Are any routinely admitted as in-patients after cataract surgery?

(a) No (b) Yes. For how many days afterwards? __________

Question 16. Which type of anaesthetic(s) do you use for cataract surgery?
(If you use more than one, record the % for each type)

(a) Retrobulbar %
(b) Peribulbar %
(c) Subtenons %
(d) Subconjunctival %
(e) Topical %
(f) General anaesthetic ______ %
100 %

Question 17. Which cataract extraction technique(s) do you routinely perform?
(If you use more than one, record the % of procedures for each technique)

(a) Phacoemulsification %
(b) ECCE %
(c) Other ______ % Specify: ______________________________
100 %

Question 18. Where do you routinely make your incisions for cataract surgery?

(a) Superior (b) Temporal (c) Other

Question 19. Where do you routinely make your incisions for cataract surgery?

(a) Clear cornea (b) Limbus (c)Sclera

Question 20. Do you routinely suture your wounds?

(a) No (b) Yes

CHEMOPROPHYLACTIC REGIMES

Question 21. Do you routinely use topical antibiotics before cataract surgery?
(a) No --> Go to question 24 (b) Yes

Question 22. When do you routinely commence pre-operative topical antibiotics?
(a) Day of surgery (b) ________ days before surgery

Question 23. Which topical antibiotic do you routinely use pre-operatively? (assuming no allergy)
(a) Chloramphenicol (b) Tobramycin (c) Gentamicin
(d) Ofloxacin (e) Other. Specify: ____________________

Question 24. Which antiseptic do you routinely use before cataract surgery? (assuming no allergy)
(a) None --> Go to question 27 (b) Betadine (c) Chlorhexidine
(d) Other. Specify: ____________________

Question 25. Do you routinely apply the antiseptic to the conjunctival sac before surgery?
(a) No (b) Yes

Question 26. Is there a certain period of time that you always leave the antiseptic before flushing or wiping dry?
(a) No (b) Yes. Specify duration: __________ minutes

Question 27. Do you routinely use antibiotics intra-operatively or immediately at the end of surgery?
(a) No --> Go to question 29 (b) Yes

Question 28. How do you administer the antibiotics and which one do you routinely use?
(circle all that apply)
(a) With irrigation fluid. Antibiotic:______________ Dose:________
(b) Intracameral injection. Antibiotic:______________ Dose:________
(c) Subconjunctival injection. Antibiotic:______________ Dose:________
(d) Topical antibiotic. Antibiotic:______________

Question 29. Do you routinely apply antiseptic to the conjunctival sac at the end of surgery?
(a) No (b) Yes. Specify antiseptic: ____________________

Question 30. Which subconjunctival steroid do you routinely use peri-operatively?
(a) None (b) Dexamethasone (c) Other. Specify: __________

Question 31. Do you routinely use topical antibiotics after cataract surgery?
(a) No --> FINISH (b) Yes

Question 32. How long do you routinely continue post-operative topical antibiotics?_______ days

Question 33. Which topical antibiotic do you routinely use post-operatively? (assuming no allergy)
(a) Chloramphenicol (b) Tobramycin (c) Gentamicin
(d) Ofloxacin (e) Other. Specify: ______________

Thankyou for taking the time to complete this survey

If relevant please provide clinical details of any endophthalmitis cases on page 4

CLINICAL DETAILS OF ENDOPHTHALMITIS CASES

Please copy a new page for each case and complete as much as possible

Patient's age: ________ years

Patient's gender: Male / Female

Date of surgery: Day ________ Month ________ 2003

Length of stay: Day-case / In-patient

Type of facility: Public / Private **AND** Hospital / Day clinic

Locality: Metropolitan / Rural / Remote

Type of operation: Phacoemulsification / ECCE / ICCE / Other. Specify: ____________________

Was an IOL inserted? No / Yes. Specify brand & model: ____________________

Wound location: Superior / Temporal / Other **AND** Corneal / Limbal / Scleral / Other

Was the wound sutured? No / Yes

Which pre-operative antiseptic was used? None / Betadine / Chlorhexidine / Other. Specify: ________

Where was antiseptic applied? Skin / Conjunctiva / Skin and conjunctiva / Not used

Antibiotic prophylaxis at the time of cataract surgery:

Pre-operative (topical):	No / Yes	Type: ____________	
Intra-operative (with irrigation fluid):	No / Yes	Type: ____________	Dose: ________
Intra-operative (intracameral injection):	No / Yes	Type: ____________	Dose: ________
Intra-operative (subconjunctival injection):	No / Yes	Type: ____________	Dose: ________
Peri-operative (topical):	No / Yes	Type: ____________	
Post-operative (topical):	No / Yes	Type: ____________	

Peri-operative subconjunctival steroid? No / Yes Type: ____________ Dose: ________

Date of endophthalmitis diagnosis: Day________ Month________ 2003

Which samples were taken for culture? (circle all relevant) None / AC tap / Vitreous tap / Vitrectomy

Which sample were culture positive? (circle all relevant) None / AC tap / Vitreous tap / Vitrectomy

Which organisms were cultured?

1.____________________ Antibiotic resistance:____________________
2.____________________ Antibiotic resistance:____________________
3.____________________ Antibiotic resistance:____________________
4.____________________ Antibiotic resistance:____________________

What was the visual acuity at diagnosis? ______ / ______

What was the last known visual acuity? ______ / ______ on Day______ Month______ Year______

Please specify any further procedures or treatment given:

Other comments:

4

Patient medical information collection form

Data collection form

Management and cost of treating Post-operative Endophthalmitis

Date
Case no.
Year-
Hospital-
AN Cost wt.
ALOS

	Resources used	Cost ($)
1.Number of days in hospital		
2.Investigations		
• MC + S		
• Ultrasound		
• other test performed		
3. Medical cost(In hospital) Which antibiotic?		
1.		
2.		
4. Other antibiotics used after discharge		
1.		
2.		
3.		
4.		
5.Vitrectomy(diagnostic or therapeutic)		
6.Other interventions		
7. Post-treatment consultations		
In-hospital out patient		
Other Doctors		
Other procedure		
Notes:		

Presentations

Poster Presentation

This study was presented at following conference:

Royal Australia and New Zealand College of Ophthalmologist (RANZCO) annual conference in Hobart, Australia in November 2005

Tittle-Cataract surgery practice and endophthalmitis prophylaxis by Australian and New Zealand ophthalmologists

D. Rosha[1], J. Ng[2], N. Morlet[3], D.Hendrie[2], B. Sunderland[1]

[1]School of Pharmacy, Curtin university of technology, Perth WA, [2]School of population health, University of Western Australia, Perth, [3] Royal Perth hospital, Perth WA.

Aim: Examine current cataract surgery and chemoprophylaxis practice and determine associations with self-reported rates of postoperative endophthalmitis.

Methodology: We surveyed Fellows and trainees of the Royal Australian and New Zealand College of Ophthalmologists and achieved an 81.7% response. Descriptive statistics and Poisson regression was undertaken to examine regional and demographic differences in practice and to investigate associations between self-reported rates of endophthalmitis and surgeon's usual surgical practice.

Result

1. Self reported rates of endophthalmitis varied regionally, being lowest in Victoria (0.33 per 1,000 operations) and highest in the Northern Territory (1.77 per 1,000).
2. The incidence in New South Wales (Incidence rate ratio [IRR] 2.46, 95% confidence interval [CI] 1.18-5.14), Queensland (IRR 3.06, 95% CI 1.27-7.38), Western Australia (IRR 2.64, 95% CI 1.11-6.30) and the Northern Territory (IRR 6.14, 95% CI 1.69-22.32) were significantly higher than Victoria.
3. Endophthalmitis incidence was 50% lower with subconjunctival antibiotics (IRR 0.49, 95% CI 0.28-0.85).
4. Surgeons using corneal (IRR 4.94, 95% CI 1.15-21.16) and to a lesser extent limbal incisions (IRR 4.47, 95% CI 1.00-19.89), had higher rates of endophthalmitis than those using scleral wounds.

Conclusion There were regional variations in the incidence of postoperative endophthalmitis that were not completely explained by surgical style or chemoprophylaxis usage.

Oral Presentation

This study was presented at following conference**:**

Australasian Pharmaceutical Science Association (APSA) annual conference in Melbourne, Australia in December 2005

Tittle: Chemoprophylaxis and cataract surgery

D. Rosha[1], B. Sunderland[1], D. Hendrie[2], J. Ng[2], N. Morlet[3]

[1]School of Pharmacy, Curtin University of Technology, Bentley, WA, [2]School of Population Health, The University of Western Australia, Crawley, WA, [3]Royal Perth Hospital, Perth WA.

Aim: Examine the different types of prophylaxis used by ophthalmologists to prevent endophthalmitis after cataract surgery.

Methodology: We surveyed Fellows and trainees of the Royal Australian and New Zealand College of Ophthalmologists and achieved an 81.6% response. Descriptive statistics and Poisson regression was undertaken to investigate associations between self-reported rates of endophthalmitis and surgeon's usual surgical practice and use of antibiotics.

Results

Preoperative antiseptic (99.4%) and postoperative topical antibiotics (97.0%) were used by almost all surgeons.

Other less commonly used regimes were subconjunctival antibiotics (42.2%) and preoperative topical antibiotics (37.0%).

Only 7.2% of surgeons added antibiotics to the irrigation fluid whilst 4.6% surgeons gave intracameral antibiotics. There was some variation in the type of antibiotics used. Chloramphenicol was the most frequently used topical antibiotic in Australia (60.3%) whilst New Zealand surgeons preferred neomycin (68.4%).

Multivariate regression analysis found that the use of subconjunctival antibiotics halved the incidence of postoperative endophthalmitis (incidence rate ratio 0.53, 95% confidence interval 0.30-0.92).

Other forms of chemoprophylaxis (preoperative topical antibiotics, preoperative conjunctival sac antiseptics, irrigation fluid or intracameral antibiotics, perioperative topical antibiotics,

postoperative conjunctival sac antiseptic, postoperative topical antibiotics) were not associated with a significantly reduced risk of self-reported endophthalmitis.

Conclusion: Use of subconjunctival antibiotics was associated with a significantly reduced rate of postoperative endophthalmitis.