Trends in cataract surgery and post-operative endophthalmitis in Western Australia (1980–1998): A population-based study

James B Semmens, Jianghong Li

Department of Public Health, The University of Western Australian

Nigel Morlet on behalf of teamEPSWA

Department of Ophthalmology, Royal Perth Hospital

Dr James Semmens

Department of Public Health, The University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6907, ph: (08) 9380–1716, fax: (08) 9380–1188, email: james@dph.uwa.edu.au

Abstract

Objectives

Post-operative endophthalmitis results from an intra-ocular infection and usually occurs following cataract surgery. It has significant morbidity and causes severe visual impairment or blindness of the eye. The aim of this study was to assess the trends in the incidence rates of cataract surgery and post-operative endophthalmitis in Western Australia for the period 1980 to 1998.

Methods

The Western Australian Record Linkage Project was used to link the morbidity records for all patients treated for cataract surgery in Western Australia in 1980–98. Patient records were selected using the international classification for diagnosis and procedure codes pertaining to cataract surgery and post-operative endophthalmitis. All cases of post-operative endophthalmitis were validated by case-note review. The separate databases of the Royal Perth Hospital microbiology and anaesthetic departments as well as the vitreo-retinal surgeon logbooks were used to cross-validate the hospital morbidity database. Trends in the incidence rates of cataract surgery and post-operative endophthalmitis were assessed by Poisson regression.

Results

There were 94,653 cataract procedures performed for 63,007 patients in Western Australia during the 19-year period. The majority (88%) of cataract procedures performed were in patients aged 60 years or older. Post-operative endophthalmitis developed in 188 patients, with serious visual impairment occurring in 70.6% of patients for whom visual acuity data was available at presentation. Cataract surgery and post-operative endophthalmitis were more common in women compared to men. The incidence rate of cataract surgery increased more than three-fold from 1981 (102 per 100,000 PY) to 1998 (345 per 100,000 PY), mainly due to the increase in extracapsular cataract extraction during the 1980s and phaco-emulsification extraction from 1990 onwards. In contrast, the average annual incidence rate of post-operative endophthalmitis remained relatively unchanged at around 2 per 1,000 cataract procedures over the same period.

Discussion

Cataract surgery is becoming more prevalent in the elderly as the life expectancy of the population increases. There has been a dramatic shift in surgical practice during the last 20 years with small incision phaco-emulsification being the predominant method of intervention used since 1990. Despite changes in surgical practice the incidence rate of post-operative endophthalmitis has remained the same.

Introduction

Post-operative endophthalmitis is a serious intra-ocular infection that occurs most commonly as a complication of intra-ocular surgery and causes severe visual impairment or the loss of an eye.[1–8] As cataract extraction is the most common intra-ocular operation, most cases of endophthalmitis follow cataract surgery. Although the reported rate of post-operative endophthalmitis is low, the prevalence of endophthalmitis has increased significantly with the increasing number of cataract procedures performed.

During the last 30 years there have been significant changes in surgical practice for cataract extraction. Intracapsular extraction was the main method used until the late 1970s; extracapsular extraction became the preferred method in the early 1980s due to the introduction of intra-ocular lens implantation; and improved instrumentation has led to the predominant use of small incision phaco-emulsification since the late 1980s. The current state of the art is sutureless phaco-emulsification surgery with injected foldable intra-ocular lenses. Although some have described a fall in the incidence rate of post-operative endo-

phthalmitis following extracapsular cataract surgery,[9–12] it was unknown if the transition to small incision phaco-emulsification further reduced the risk of post-operative endophthalmitis. Previous studies that attempted to address this question did not take into account the learning curve of surgeons following the transition from extracapsular extraction to phaco-emulsification because of the lack of long-term data.[10, 12] While concerns about an increased risk of endophthalmitis with phaco-emulsification surgery were raised, they have yet to be convincingly demonstrated.[13] As phaco-emulsification surgery is almost universally performed in Australia today, the lack of information regarding the risk of post-surgical endophthalmitis is a significant gap in our knowledge of the safety of this new method of surgery.

Most existing analyses of post-operative endophthalmitis have utilised data derived from individual centres or groups of surgeons which resulted in very low case numbers, making comparisons and statistical validity of data difficult.[9, 10, 12] The rarity of the disease means that a randomised control trial is not the appropriate methodology to study this adverse outcome. With the development of the Western Australian Record Linkage Project which completely encompasses a geographically isolated and generally stable population of 1.9 million people, the opportunity now exists to examine ophthalmic data for a whole community.[14] Isolation and minimal net migration into the State enables almost complete ascertainment of peri-operative data using the linkage of health records.

As part of the Western Australian Safety and Quality of Surgical Care Project,[15] we used record linkage of health data supplemented by case validation to provide population-based estimates of the incidence rates of cataract procedure and post-operative endophthalmitis.

Patients and methods

The Western Australian Record Linkage Project was used to extract hospital morbidity data for all patients who were surgically treated for cataract or diagnosed with endophthalmitis in 1980–1998. Patient morbidity data was selected using the international classification codes for the diagnosis and procedures: ICD–9 and ICPM for 1980–87, and its modification, ICD–9-CM for 1988–98.[16–19] Cataract procedures included intracapsular extraction of lens (ICD–9 codes: 5–144; ICD–9-CM codes: 13.11, 13.19), extracapsular extraction (linear/aspiration/other) (ICD–9 codes: 5–142, 5–145; ICD–9-CM codes: 13.2, 13.3, 13.51, 13.59), phaco-emulsification (ICD–9-CM codes: 13.41–13.43), other cataract extraction (ICD–9 codes: 5–146; ICD–9-CM codes: 13.64, 13.65, 13.66, 13.69) and cataract-related lens operations (ICD–9 codes: 5–147, 5–149; ICD–9-CM codes: 13.70–13.72, 13.9). Endophthalmitis cases were identified using ICD–9 diagnosis codes 360.0 and 360.1 and ICD–9-CM codes 360.00–360.04 and 360.11–360.19. Postcode data was used to classify patients as residing in metropolitan Perth or country areas (rural and remote) following the Health Zone classification system of the Health Department of Western Australia.

Database validation

An extensive program of validation was carried out for all patients coded with endophthalmitis by medical record review, and the use of other specific data sources including the microbiology and anaesthetic databases from Royal Perth Hospital (Perth, Western Australia), and surgeon log-books. Of the 63,007 patients who were treated for cataract in the study period, 538 patients were coded with endophthalmitis in 1980–1998. An additional 160 patients were identified as possible post-operative endophthalmitis cases from the other data sources described above. Validation of the records of these patients confirmed 188 cases as having post-operative endophthalmitis. Data on visual impairment was available for 109 patients with post-operative endophthalmitis and the visual impairment was assessed by the treating ophthalmologist at the time of admission using the Snellens visual acuity chart. A more detailed summary of the accuracy of codes used for cataract surgery and post-operative endophthalmitis is provided by the authors elsewhere.[20]

Statistical analyses

Descriptive analyses were carried out using the statistical program, SPSS.[21] Annual age-specific and age-standardised rates for cataract procedures per a case 100,000 person years (PY) were estimated using the World Standard Population as the standard set of weights.[22] The incidence rate of post-operative endophthalmitis was calculated per 1,000 cataract procedures and differentiated by surgical type, locality (metropolitan, rural and remote) and hospital type (public and private). Poisson regression was used to assess whether these factors affected the incidence rate of post-operative endophthalmitis and to estimate the overall trends in cataract procedures and post-operative endophthalmitis. Hospital-specific trends in cataract procedures were estimated using linear regression.

Results

Descriptive analysis

There were 94,653 cataract procedures performed on 63,007 patients in Western Australia during the 19-year period, of which 188 patients developed post-operative endophthalmitis (Table 1). The majority (88%) of patients treated for cataract disease were over 60 years of age and 72% were 70 years or older. The increase in cataract operations was most striking among patients aged 70–79 years (Figure 2c). The mean age (_SD) of women receiving cataract surgery was around four years older than men receiving surgery (74.3 _ 14.7 years , 70.6 _ 14.2 years, p<0.0001, respectively) and a similar trend was apparent for post-operative endophthalmitis. Cataract surgery (58%) and post-operative endophthalmitis (65%) were more common in women compared to men. Serious visual impairment occurred in many patients (N=109) with 70.6% being classified as either blind or with severe visual impairment at presentation.

Trends in cataract procedure 1980–1998

The number of cataract procedures performed annually increased 7-fold, from 1,335 in 1980 to 9,653 in 1998. The age-standardised incidence rate of cataract procedure per 100,000 PY is presented in Figure 1a. The adjusted rate ratio increased by 6.13% per year (RR, 1.063; 95% CI, 1.06–1.064). In the early 1980s, the frequency of cataract intervention in men and women were similar. Since 1984, there has been a greater increase in surgical intervention for cataract in women compared to men (Figure 2d). Gender-specific trend analysis showed that the adjusted incidence rate ratio increased 6.5 % per year in women (RR, 1.065; 95% CI, 1.063–1.067), compared with 5.7 % per year in males (RR, 1.057; 95% CI, 1.055–1.059).

The increase in cataract procedures over the study period was largely attributed to the increase in extracapsular cataract extraction (aspiration, linear and other), and phaco-emulsification from 1990 onwards (Figure 1b). Since 1990, the use of phaco-emulsification increased by around 166% per annum, while the use of extracapsular extraction stabilised in 1987–1992 and declined thereafter. Intracapsular extraction and other cataract extraction (including cataract-related lens operations) remained relatively constant over the study period despite of a small increase in other cataract extraction between 1987 and 1991 and an increase in intracapsular procedure between 1992–1994.

The majority of cataract procedures (81%) and post-operative endophthalmitis cases (73%) occurred in the metropolitan area throughout the study period (Table 1, Figure 2a). There was a slight increase in the rural area from 1993 onward, while the number of operations in remote areas remained stable throughout the study period.

While a similar proportion of cataract procedures were performed in public and private hospitals, there was a greater increase in the number of cataract procedures carried out in private hospitals compared to public hospitals, particularly apparent from 1990 onwards (Table 1, Figure 2b). The average rate of increase in cataract procedures in private hospitals (17% p.a., 289 procedures p.a.) nearly doubled that in public hospitals (8.8% p.a., 145 procedures p.a. p = 0.001) (Table 2).

Trends in post-operative endophthalmitis

In contrast to the increase in the incidence rate of cataract operations, the incidence rate of post-operative endophthalmitis remained relatively constant at around 2 per 1,000 cataract procedures throughout the study period despite the transition from intracapsular cataract extraction to extracapsular extraction and then to predominantly phaco-emulsification (Table 1, Figure 1a).

The trends in the incidence rate of post-operative endophthalmitis by cataract procedure type, locality and hospital type remained stable throughout the study period (Table 3). In contrast to extracapsular, phaco-emulsification and lens procedures, there was a two-fold increase in the incidence rate of post-operative endophthalmitis among patients who had undergone other cataract surgery from 1990–94 to 1995–98. However, this increase did not reach statistical significance due to the small number of cases (RR 2.438, 95%CI, 0.583–10.203, p =0.222).

The overall incidence rate of post-operative endophthalmitis was significantly higher for intracapsular extraction than for extracapsular (linear/aspiration/other) and phaco-emulsification (Table 3). However, we found no significant difference between extracapsular procedures and phaco-emulsification (RR, 0.91; 95% CI, 0.61, 1.35).

The incidence rate of endophthalmitis is higher in rural than metro areas but there was no significant difference between remote and metro areas. There is no substantial difference between public and private hospitals where the relevant cataract surgery was performed (Table 3).

Discussion

The last two decades have seen a dramatic increase in patients receiving surgical treatment for cataracts in Western Australia. The trend may reflect the increasing prevalence of the disease in the elderly population as life expectancy increases. Cataract surgery was mainly associated with people aged 60 years or older, with those aged 70 years or more providing the greatest increase in demand for surgical treatment. Around 36% more women were treated for cataract than men and these women were on average four years older.

Consistent with international trends, surgical treatment for cataract has shifted from intracapsular extraction to extracapsular extraction, then to predominantly small incision phaco-emulsification from 1990. Post-operative endophthalmitis is a serious complication of ocular surgery and results from an infection of the internal structures of the eye. As with cataract surgery, there was a greater proportion (62%) of women affected by the post-operative endophthalmitis than men (38%). The consequence of the disease to the patient and surgeon is devastating: around 70% of affected patients suffered severe visual impairment and/or blindness. While the incidence rate of post-operative endophthalmitis remained relatively unchanged at 2 per 1000 cataract procedures, the rapid rise in cataract surgery has resulted in a seven-fold increase in the crude number of patients with this complication during the study period and doubled during the last ten years of the study. Approximately 30 patients are now diagnosed with post-operative endophthalmitis each year in Western Australia, or around 300 cases per year in Australia. The cumulative long-term consequences of this condition create significant emotional, physical and economic burdens to the community.

The incidence rate of post-operative endophthalmitis halved as surgical practice shifted away from intracapsular extraction to extracapsular extraction and phaco-emulsification. However, given the relatively small number of intracapsular procedures performed since 1980, this reduction had no effect on the overall trend of post-operative endophthalmitis over the study period. The incidence rate of post-operative endophthalmitis was similar for extracapsular extraction and phaco-emulsifica-

tion, which is consistent with other reports from Europe and North America.[12, 23–25] This finding is of interest because it was anticipated that the introduction of small-incision phaco-emulsification would further reduce the risk of post-operative endophthalmitis. A number of reasons may account for the unchanged rate of endophthalmitis with change in surgery; the phaco-emulsification technique is technically more difficult than extracapsular extraction and requires more time to gain surgical proficiency; and variations in the technique (eg, suture versus sutureless) have occurred since its introduction. Previous studies failed to present a clear answer to the question of whether the sutureless phaco-emulsification procedure posed a higher risk for bacteria access to the eye possibly due to small number of post-operative endophthalmitis patients and the limited time period available for analysis.[25] In addition, both the extracapsular and phaco-emulsification techniques frequently involve the insertion of an intraocular lens which provides a potential pathway for the introduction of bacteria.[25]

During the last two decades, the greatest increase in cataract procedures in Western Australia occurred in the metropolitan area as would be expected given the centralisation of the health services, facilities and technological resources. There was also a significant increase in procedures performed in private hospitals which most likely resulted from the introduction of small-incision phaco-emulsification. This technique has made cataract extraction efficient and affordable on an outpatient basis and is also considered by the ophthalmologists to have a safer wound than the previous methods.

The increase in the incidence rate of post-operative endophthalmitis following 'other cataract extraction' between 1995–1998 may be attributed to the higher risk of infection resulting from additional eye procedures performed during cataract surgery (eg. anterior vitrectomy).[12] Diabetes has also been reported to be a factor associated with an increased risk of endophthalmitis.[26, 27]

There have been three large-scale studies on post-operative endophthalmitis: two were conducted in the U.S.[10,12] and one in France.[9] It is difficult to make direct comparison of our results of the incidence rate of post-operative endophthalmitis with previous estimates due to different study methodology. It is possible, however, to compare the completeness and accuracy of our data with those of the datasets on which the previous national studies were based. The Western Australian Record Linkage Project has provided a unique opportunity to generate a population-based estimate of post-operative endophthalmitis and analyse the social and demographic trends of the disease over last the 19 years. The data for our study has been validated by chart review for endophthalmitis cases and some of the cataract procedures. In contrast, the three previous national studies covered only a short time span of two years, and were not population-based estimates. Two of the studies excluded patients with multiple cataract procedures and those who underwent other ocular surgeries during the cataract procedure from their investigations due to difficulties in ascertaining the causal procedure. Since those patients may represent a high-risk group, the exclusion may have underestimated the incidence rate of post-operative endophthalmitis.[10,12] The use of population-based data complemented by case validation for all patients coded with post-operative endophthalmitis in the present study gives us confidence about our findings.

This paper reports on the trends in cataract surgery and the incidence rate of post-operative endophthalmitis during the last two decades. Further research is currently being carried out in a nested case-cohort study of patients to examine the risk factors that may contribute towards the disease and to assess the effectiveness of the different methods of chemoprophylaxis used during cataract surgery. This research will enable a more accurate estimate of the costs involved to prevent or treat the disease and will provide a framework for policy makers to determine the provision of ophthalmic services.

Demographic variables	Cataract procedure (N =94653)	Endophthalmitis case (N=188)
Age		
0-49	4041 (4.3%)	10 (5.3%)
50-59	6501 (6.9%)	17 (9.0%)
60-69	18489 (19.5%)	25 (13.3%)
70-79	38997 (41.2%)	67 (35.6%)
80 +	26619 (28.1%)	69 (36.7%)
Missing	6	
Sex		
Female	54655 (57.7%)	117 (62.2%)
Male	39998 (42.3%)	71 (37.8%)
Locality		
Metro	76597 (80.9%)	137 (72.9%)
Rural	14717 (15.5%)	40 (21.3%)
Remote	3071 (3.2%)	10 (5.3%)
Missing	268 (0.3%)	1 (0.5%)
Hospital		
Public	46154 (48.8%)	84 (44.6%)
Private	48434 (51.1%)	104 (55.4%)
Not classified	65	
Surgical type		
Intra-capsular extraction	5024 (5.3%)	18 (9.6%)
Extra-capsular extraction	46298 (48.9%)	76 (40.0%)
Phaco-emulsification	32355 (34.2%)	64 (34.0%)
Other cataract procedure	8203 (8.7%)	19 (11.1%)
Lens procedure	2770 (2.9%)	8 (4.3%)
Surgical type unknown	3	3 (1.6%)
Visual impairment (N= 109)		
No perception of light		3 (2.8%)
Worse than 6/60		74 (67.8%)
6/36 to 6/60		23 (21.1%)
6/12 to 6/24		9 (8.3%)

Table 1 Demographic characteristics of patients treated for cataract and for those who developed post-operative endophthalmitis

Year	Public		Private		Difference	95% CI	T-value
	No.	%	No.	%			
1980-90	193**	12.3	201**	19.7	-8	-71, 55	-.25
1991-98	122*	4.3	462**	13.6	-340	-444, -236	-6.41
All years	163**	8.8	274**	17.0	-111	-151, -71	-5.47

** $p < 0.001$ * $p < 0.01$

Table 2 Differences between hospital types in average annual increase in cataract surgery

	1980/84	1985/89	1990/94	1995/98	All years	Rate ratio (all years)	Z score	95% CI	P-value (2-tail)
Surgical type									
Intracapsular (reference)	3.93	3.48	4.60	0	3.58	-----	-----	----------	-----
Extracapsular	1.27	1.70	1.63	1.76	1.64	0.469	-2.88	0.280, 0.785	0.004
Phaco-emulsification	NA*	NA*	1.96	1.99	1.98	0.516	-2.28	0.292, 0.912	0.023
Other cataract	2.66	0.90	2.39	5.83	2.32	0.649	-1.30	0.337, 1.248	0.195
Lens procedure	0	2.33	4.85	3.95	2.89	0.806	-0.51	0.350, 1.856	0.612
Area									
Metro (reference)	1.51	1.55	1.97	1.86	1.79	-----	-----	----------	-----
Rural	4.60	1.61	2.50	2.93	2.72	1.459	2.03	1.014, 2.100	0.042
Remote	4.53	5.19	2.99	1.91	3.26	1.823	1.81	0.953, 3.488	0.070
Hospital type									
Private (reference)	2.69	1.54	2.20	2.30	2.15	-----	-----	----------	-----
Public	1.88	1.77	1.96	1.69	1.82	0.809	-1.38	0.599, 1.093	0.167
Time									
Year						1.048	0.51	0.875, 1.254	0.610

*NA - not applicable

Table 3 Differences in the incidence rate of post-operative endophthalmitis (per 1,000) by surgical type, locality and hospital for the period 1980–1998

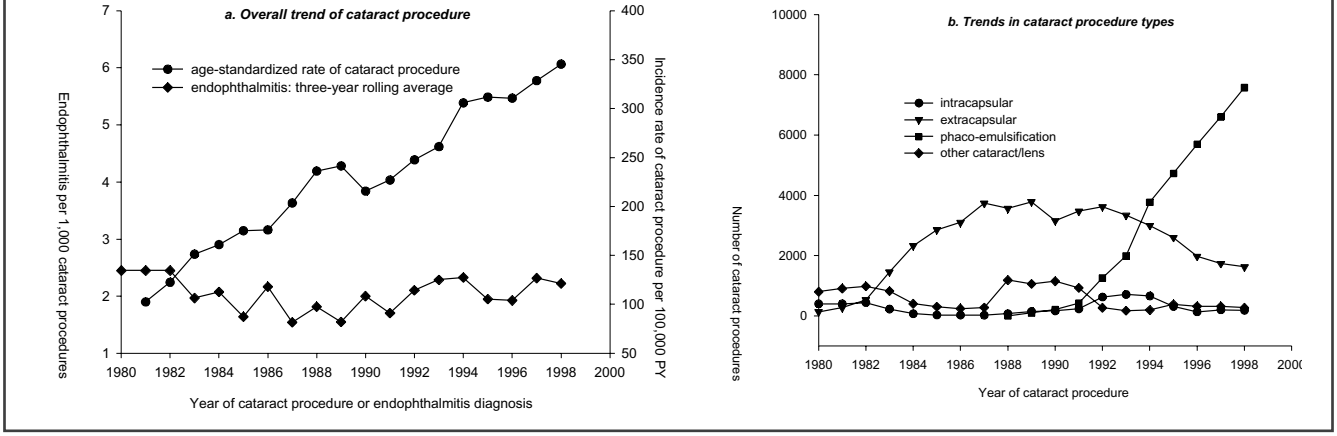

Figure 1 Trends in the age-standardised incidence rate of cataract procedures and post-operative endophthalmitis (1980–1998)

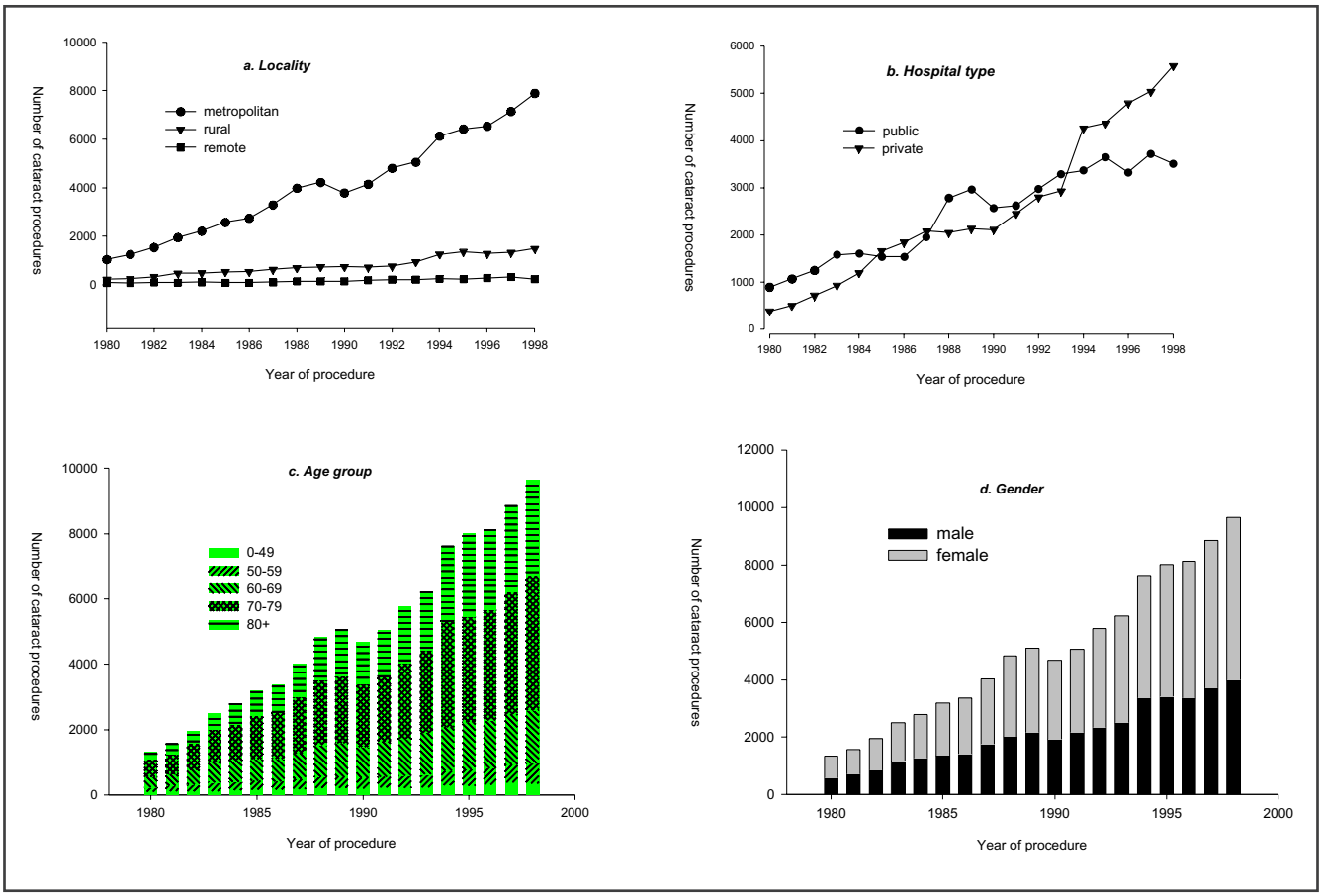

Figure 2. Demographic trends in cataract procedure in WA by locality, hospital type, age-group and gender (1980-1998)

Contributors *team*EPSWA

Nigel Morlet, Consultant ophthalmologist, Royal Perth Hospital; James Semmens, Coordinator of the Quality of Surgical Care Project, Department of Public Health, University of Western Australia (UWA); Jianghong Li, Project coordinator and research analyst; Johnathon Ng, Ophthalmology Research Registrar, data validation and analysis; Katrina Spilsbury, Chart review validation; Arem Gavin, Chart review validation; Angela Ives, Literature review; Delia Hendrie, Health economist, Department of Public Health, UWA; D'Arcy Holman, Professor, Department of Public Health, UWA; Bridget Mullholland, Ophthalmologist, endophthalmitis case validation; Ian McAllister, Consultant vitreo-retinal surgeon, Royal Perth Hospital, Associate Professor, Lions Eye Institute UWA; Chris Kennedy, Consultant vitreo-retinal surgeon, Fremantle Hospital; Tim Isaacs, Consultant vitreo-retinal surgeon, St John of God Hospital; Ian Constable, Consultant vitreo-retinal surgeon, Queen Elizabeth II Medical Centre, Professor, Lions Eye Institute, UWA; John Pearman, Professor, Department Microbiology and Infectious Disease, Royal Perth Hospital; Ferenz Kosaras, Senior scientist information technology, Department Microbiology and Infectious Disease, Royal Perth Hospital.

Acknowledgements

This study was funded by the NHMRC, Project #110250. We would like to thank the Health Information Centre of the Health Department of Western Australia for its support and close co-operation in the case validation. We extend our gratitude to Professor Matthew Knuiman, Mr Kieran M^{c}Caul and Mr Max Bulsara from the School of Population Health at The University of Western Australia and Dr David Lawrence from the Child Health Research Institute in Perth for their advice for the statistical analysis.

References

1. Leopold IH, Apt L. Postoperative intraocular infections. Am J Ophthlamol 1960;50:1225–1247.

2. Coster DJ. Postoperative ocular infections. In: Watts JM, McDonald PJ, O'Brien PE, Marshall VR, Finlay-Jones JJ, editors. Infection in Surgery. Edinburgh: Churchill Livingstone, 1981:347–351.

3. Shrader, S. K., J. D. Band, et al. (1990). The clinical spectrum of endophthalmitis: incidence, predisposing factors, and features influencing outcome. The Journal of Infectious Diseases. 162: 115–20.

4. Verbraeken, H. E. (1993). Intracapsular and extracapsular pseudophakic endophthalmitis: a comparison. Documenta Ophthalmologica. 84: 387–93.

5. Hughes, D. S. and R. J. Hill (1994). Infectious endophthalmitis after cataract surgery. British Journal of Ophthalmology. 78: 227–32.

6. Kresloff, M. S., A. A. Castellarin, et al. (1998). Endophthalmitis. Survey Ophthalmology. 43: 193–224.

7. Aaberg, T. M., Jr., H. W. Flynn, Jr., et al. (1998). Nosocomial acute-onset postoperative endophthalmitis survey. A 10-year review of incidence and outcomes. Ophthalmology. 105: 1004–10.

8. Callegan, M. C., M. Engelbert, et al. (2002). Bacterial endophthalmitis: epidemiology, therapeutics, and bacterium-host interactions. Clinical Microbiology Reviews. 15: 111–24.

9. Fisch A, Salvanet A, Prazuck T, Forestier F, Gerbaud L, Coscas G, et al. Epidemiology of infective endophthalmitis in France. The French Collaborative Study Group on Endophthalmitis. Lancet 1991;338(8779):1373–6.

10. Javitt JC, Street DA, Tielsch JM, Wang Q, Kolb MM, Schien O, et al. National outcomes of cataract extraction. Retinal detachment and endophthalmitis after outpatient cataract surgery. Cataract Patient Outcomes Research Team. Ophthalmology 1994;101(1):100–5; discussion 106.

11. Norregaard JC, Thoning H, Bernth-Petersen P, Andersen TF, Javitt JC, Anderson GF. Risk of endophthalmitis after cataract extraction: results from the International Cataract Surgery Outcomes study. Br J Ophthalmol 1997;81(2):102–6.

12. Javitt JC, Vitale S, Canner JK, Street DA, Krakauer H, McBean AM, et al. National outcomes of cataract extraction. Endophthalmitis following inpatient surgery. Arch Ophthalmol 1991;109(8):1085–9.

13. Hessburg TP, Maxwell DP, Diamond JG. Endophthalmitis associated with sutureless cataract surgery [letter] [see comments]. Arch Ophthalmol 1991;109(11):1499.

14. Holman, C. D., A. J. Bass, et al. Population-based linkage of health records in Western Australia: development of a health services research linked database. Aust NZ J Public Health 1999; 23: 453–9.

15. Semmens JB, Lawrence-Brown MMD, Fletcher DR, Rouse IL, Holman CDJ. The Quality of Surgical Care Project: a model to evaluate surgical outcomes in Western Australia using population-based record linkage. Australian and New Zealand Journal of Surgery 1998; 68: 397–403.

16. International Classification of Diseases. Manual of the international statistical classification of diseases, injuries, and causes of death. Geneva: World Health Organisation, 1977.

17. International Classification of Procedures in Medicine. Geneva: World Health Organisation, 1978.

18. The Official NCC Australian Version of ICD–9-CM. Tabular List of Diseases. First ed. Sydney, Australia: National Coding Centre, Faculty of Health Sciences, University of Sydney, 1995.

19. The Official NCC Australian Version of ICD–9-CM. Tabular List (annotated) and Index of Procedures. First ed. Sydney: National Coding Centre, Faculty of Health Sciences, University of Sydney, 1995.

20. Li J, Morlet N, Semmens JB, Gavin A on behalf of teamEPSWA. Coding accuracy for endophthalmitis diagnosis and cataract procedures in WA. Submitted Ophthalmic Epidemiology

21. Norusis MJ. SPSS for Windows. Base System User's Guide Release 5.0. Chicago: SPSS Inc., 1992.

22. Codde J. Rates Calculator. Version 8.3.x 2001: Health Department of Western Australia, Perth.

23. Versteegh MF, Van Rij G. Incidence of endophthalmitis after cataract surgery in the Netherlands: several surgical techniques compared. Doc Ophthalmology 2000; 100(1): 1–6.

24. Somani A, Grinbaum A, Slomovic AR. Postoperative endophthalmitis: incidence, predisposing surgery, clinical course and outcome. Canadian Journal of Ophthalmology 1997;32(5):303–310.

25. Montan PG, Koranyi G, Setterquist HE, Stridh A, Philipson BT, Wiklund K. Endophthalmitis after cataract surgery: Risk factors relating to technique and events of the operation and patient history. Ophthalmology 1998; 105: 2171–77.

26. Ho P C, Tolentino F. Bacterial endophthalmitis after closed vitrectomy. Arch Ophthalmol 1984; 102:207–10.

27. Kattan HM, Flynn HW Jr, Pflugfelder SC, et al. Nosocomial endophthalmitis survey. Current incidence of infection after intraocular surgery. Ophthalmology 1991; 98:227–38.