Risk of retinal detachment after phacoemulsification:

a whole-population study of cataract surgery outcomes

Antony Clark MBBS(Hons),[1,2] Nigel Morlet FRACS FRANZCO,[1,2,3] Jonathon Q Ng MBBS BA PhD, [1,2,3] David B Preen BSc(Hons) PhD, [1,3] James B Semmens MSc PhD [1,2]

[1]Eye and Vision Epidemiology Research (EVER) group, Perth, Western Australia

[2]Centre for Population Health Research, Curtin Health Innovation Research Institute, Curtin University, Perth, Western Australia

[3]Centre for Health Services Research, School of Population Health, The University of Western Australia

Funding: The Australian National Health and Medical Research Council, Project grants 110250, 303114.

Conflict of interest: The authors have no conflict of interest nor any financial interest in the material presented in this manuscript.

Short title: Retinal detachment after phacoemulsification

Presented (in part):

The Royal Australian and New Zealand College of Ophthalmologists 41st Annual Scientific Congress, November 2009, Perth, Australia.

Keywords: Retinal detachment, cataract surgery, complication, data linkage, administrative data, population-based.

Correspondence:

Dr Antony Clark

Centre for Population Health Research

Curtin Health Innovation Research Institute

Curtin University, Perth, Western Australia

Tel: +61 8 9266 1853; Fax: +61 8 9266 1866

Email: a.clark@curtin.edu.au

Abstract

Objective: To estimate the long-term cumulative incidence of retinal detachment (RD) after phacoemulsification and identify significant risk factors.

Methods: We used the Western Australian (WA) Data Linkage System to identify all patients who underwent phacoemulsification cataract extraction in WA from 1989 to 2001. Cases of RD were considered as those patients requiring inpatient admission for RD surgery after phacoemulsification surgery. Cases were validated by medical chart review. Kaplan-Meier analysis was used to calculate a cumulative incidence. Cox proportional hazards regression modeling was used to determine the association between RD following phacoemulsification and a range of potential risk factors including patient demographics, operative factors and hospital factors.

Results: There were 237 cases of RD following 65,055 phacoemulsification procedures with a 10-year cumulative incidence of 0.68% (95%CI 0.56-0.83). Significant factors associated with RD in multivariate analysis were year of surgery (HR=0.59, 95%CI 0.44-0.81 for each 5-year period after 1985), age<60 years (HR=3.76, 95%CI 2.83-5.00), male sex (HR=1.91, 95%CI 1.45-2.51), failed intra-ocular lens insertion (HR=2.28, 95%CI 1.06-4.93), and anterior vitrectomy (HR=27.60, 95%CI 19.27-39.52). Location of surgery, patient rural status, hospital cataract surgery volume, length of stay, and insurance status were not significantly associated with RD.

Conclusion: The risk of RD after phacoemulsification has almost halved for every 5 years since its adoption in the mid-1980s. Patients' younger age, male sex, and failure to insert an artificial lens at surgery significantly increased the risk of RD. Phacoemulsification requiring anterior vitrectomy vastly increased the risk of RD.

Introduction

Retinal detachment (RD) is one of the most frequent sight-threatening complications of modern cataract surgery and complicates approximately 1% of all cataract operations performed in Western countries.[1-10] Multiple risk factors are implicated including patient factors (younger age, male gender, long axial length),[1-4,8,11-14] operative factors (surgical technique, vitreous loss and posterior capsule rupture),[2,6,11,15-19] and postoperative factors (YAG laser posterior capsulotomy).[4,7] Cataract surgery technique has been implicated as a significant risk factor for subsequent RD particularly as the abandonment of intracapsular cataract extraction in favour of extracapsular cataract extraction (ECCE) during the late-1970s resulted in a significant decline in the incidence of pseudophakic RD.[6,7,20-22] The subsequent adoption of phacoemulsification cataract surgery as the current procedure of choice has maintained this reduced risk of RD,[1,2,7,22] despite initial concerns associated with the surgeon learning curve surrounding it's adoption.[6]

Population-based studies suggest the risk of RD after phacoemulsification may remain increased over 10 years following cataract surgery, yet few studies have followed patients longer than about five years.[1,2] The purpose of our study was to explore how the long-term risk of RD (12 years) after cataract surgery has changed over time since phacoemulsification was first introduced; and to identify important population-based risk factors for RD after phacoemulsification in the entire Western Australian population using validated linked health administrative data. Phacoemulsification was widely adopted in Western Australia (WA) during the late-1980s and by the mid-1990s had become the procedure of choice in the vast majority of cataract surgeries.[23] The WA Data Linkage System (WADLS) links routinely-collected health administrative datasets across the entire WA population with data sets dating back to 1966,[24] and provides the unique ability to study long-term postoperative complications of phacoemulsification on a whole-population level.

Methods

We conducted a whole-population retrospective longitudinal study of RD after phacoemulsification using linked administrative data in WA from 1989 to 2001.

Study population

In WA all cataract and lens-related surgery may only be performed in health facilities licensed with the WA Department of Health. All facilities are required to provide data from all admissions, including patient demographics, co-morbidities, primary and secondary diagnoses, and any procedures undertaken or complications arising during the admission. This data, encompassing all admissions from all WA hospitals (public and private), form the Hospital Morbidity Data Collection (HMDC); one of the core data sets of the WADLS.[24]

We extracted hospital discharge data from the HMDC for all patients who underwent phacoemulsification cataract surgery during 1989 to 2001. Linkage with the State Mortality Register allowed us to account for loss-to-follow-up due to patient deaths. Phacoemulsification procedures were identified using the time period relevant International Classification of Diseases (ICD) codes for procedures (ICD-9-CM: 13.41 – 13.43; ICD-10-AM: 42698-02, 42698-03, 42702-04, 42702-05, 42702-06, 42702-07).[25,26]

Case validation

All inpatient admissions for RD surgery were identified using specific ICD procedure codes associated with RD repair (ICD-9-CM: 14.3 – 14.59, 14.9; ICD-10-AM: 42773-00, 42773-01, 42776-00, 42809-01, 90079-00). Only RD procedures that occurred after the associated phacoemulsification procedure were considered. Potential cases where a RD occurred prior to the first ever cataract extraction operation, where eye trauma was involved or where vitreo-retinal surgery was performed concurrently were excluded.

As detailed elsewhere,[22] all potential cases were validated by reviewing the patient medical record to confirm the phacoemulsification operation and RD occurred in the same eye. Other important operative information such as procedure type, intra-ocular lens (IOL) insertion, IOL type and any other concurrent procedures were also recorded.

Statistical analysis

Age was stratified into ten-year age groups (<50, 50-59, 60-69, 70-79, 80+ years). Patient location was defined as rural/remote or metropolitan based on residential postcode at time of surgery. Health insurance status (public or private) was also recorded. The hospital of cataract surgery was classified as public or private; and rural/remote or metropolitan. We also considered the volume of cataract surgery performed at each institution over the study period where the 'largest' performed >5,000 procedures (n=2), 'large' performed 2,000 – 5,000 procedures, 'medium' 500 – 1,999 procedures, and 'small' <500 procedures. Length of stay was divided into same-day, overnight, and >1 day. Year of surgery was grouped as 1989 – 1993, 1994 – 1998 and 1999 – 2001.

Kaplan-Meir analysis was used to calculate a cumulative incidence of RD (as a percentage of cataract procedures) whereby patients were censored at time of death or end of follow-up. A Cox proportional hazards model was used to assess the relative risk for each risk factor examined which were reported as hazard ratios (HR) and corresponding 95% confidence intervals (CI) for each risk factor examined. Standard Errors (SE) were adjusted for clustering of procedures around individuals using generalized estimating equations. Important risk factors in the Cox model were selected using a backwards stepwise selection procedure, whereby all covariates were included in an initial model and the variable with the highest P-value sequentially removed until the most parsimonious model remained whereby the P-value for all variables was < 0.05 All statistical analyses were performed using Stata 10.0 (StataCorp, College Station, TX).

Ethical considerations

This study was approved by the human research ethics committees at Curtin University, The WA Department of Health, and each of the hospitals involved in the study. All data analysis was carried out on de-identified data. Patient information was provided only for potential cases for the purposes of data validation.

Results

There were 65,055 phacoemulsification operations performed on 46,258 patients in WA between 1989 and 2001, of which 237 (0.36%) were associated with a subsequent admission for surgery for RD (Table 1). The crude incidence of RD after phacoemulsification declined by an average of 19% for each year after 1989 (IRR=0.81, 95%CI 0.77-0.84) (Figure 1a). The median time to RD after phacoemulsification was 11 months (range 0 - 8.4 years) with the cumulative incidence increasing almost linearly from 0.47% (95%CI 0.41-0.54) at 5 years, to 0.68% (95%CI 0.56-0.83) by 10 years after surgery (Figure 1b). Characteristics of the patients undergoing phacoemulsification and that of the cases are summarized in Table 1.

The mean age ± standard deviation (SD) of patients who had cataract surgery was 73.7 ± 10.3 years (range 4 - 104.4 years). Men were slightly younger than women at the time of surgery (mean difference=2.4 years, 95%CI 2.2-2.6, p<0.001). The majority were female (58.4%), lived in the metropolitan area (84%), and were privately insured (64%).

The mean age ± SD of RD cases was 64.4 ± 12.9 years (range 24 -93 years) and 62.4% were men. Younger age and male sex were significantly associated with an increased risk of RD identified in the univariate and multivariate Cox proportional hazards model (Figure 2a-b). Compared to those over 60 years, patients younger than 60 years had almost 4-times the risk of RD (HR=3.76, 95%CI 2.83-5.00, p<0.001). Men were approximately twice as likely to have a RD following their cataract surgery (HR=1.91, 95%CI 1.46-2.51, p<0.001) compared with women. Age was not significantly different between sexes among cases of RD (p=0.21). Other patient factors including location of residence and private insurance status were not independently associated with risk of RD.

There were very few procedures where an IOL was not inserted (n=432, 0.7%). Failure to insert an IOL was associated with an almost 5-fold increased risk of subsequently having a RD in the univariate analysis (HR=4.86, 95%CI 2.57-9.20, P<0.001) and over twice the risk after adjustment for all other risk factors in the multivariate model (HR=2.28, 1.06-4.93, P=0.036). However, it was not significant in the backwards-stepwise variable selection model (excluded at P=0.056).

Anterior vitrectomy was performed in 1% (643) of all phacoemulsification cataract operations and in 20.2% (n=48) that resulted in a RD. The 5-year cumulative incidence of RD after phacoemulsification were anterior vitrectomy was performed was 8.31% (95%CI 6.14-11.20) and increased to approximately 15% by the end of follow-up (Figure 2d). Anterior vitrectomy was associated with a significant increase in the risk of RD to almost 30-times greater than operations where no anterior vitrectomy was performed (HR=28.96, 95%CI 20.43-41.05, P<0.001).

The crude incidence of anterior vitrectomy during cataract surgery declined in the first few years of phacoemulsification adoption in WA and leveled off thereafter at a rate of 10 per 1,000 phacoemulsification cataract procedures performed (Figure 3). The crude incidence of RD after cataract surgery showed a similar decline early in the study period and has continued to decline despite the rate of anterior vitrectomy remaining constant (Figure 3).

Most cataract operations were performed in metropolitan hospitals (90%) and 64% were in private facilities. Two hospitals in WA performed >10,000 cataract procedures accounting for 37.9% of all phacoemulsification operations performed in the State. There were 23 facilities where < 500 phacoemulsification operations were performed which accounted for less than 5% of the total cohort. The majority (14/23) of these facilities were hospitals from rural/remote areas. A significant proportion (83%) of operations involved either day case or over-night admissions. None of the hospital variables (location, surgical volume and private status) were significantly associated with the risk of RD either in univariate analysis or the multivariate model (Table 1).

Most phacoemulsification operations (50.3%) were performed between 1999 and 2001. There was approximately a 50% reduction in the incidence of RD in each subsequent year group from a high of 0.96% during 1989-1994 to a low of 0.25% during 1999-2001 (Figure 2c). After adjusting for all significant variables in the multivariate model, the year of surgery remained significantly associated with the risk of RD such that by the 1999-2001 period, the HR compared to the 1989-1994 period was 0.43 (95%CI 0.28-0.56, $P<0.001$).

Comment

The incidence of RD after phacoemulsification in WA reduced significantly over time with a steady decline in the 5-year cumulative incidence from 0.96% during 1989-1993, to 0.43% during 1995-1998, and then to 0.25% by 1999-2001. This reduction remained significant after adjustment for patient sociodemographic, surgical and hospital factors. The large fall in incidence from the period representing the adoption of phacoemulsification into routine clinical practice in WA (1989-1993) to plateau thereafter is likely due to surgeon learning curve, although other unmeasured factors such as improvement in surgical technique and advances in equipment technology may also have contributed to this result.

Our findings are comparable with the incidence of RD after phacoemulsification reported elsewhere.[1-12,14,18,19] However, many of these studies were limited by their smaller sample sizes,[4,7-11,14,18,19] involved single clinical centres,[4,7-11,14,18,19] or had short follow-up (<5 years).[5,10,14,18,19] Our whole-population-based study captured the entire cohort of patients undergoing phacoemulsification in a well-defined population of 2.2 million people that is representative of the Australian context.[27,28] The WA population has also been shown to have comparatively low emigration rates out of the State thereby representing a stable population for longitudinal observation.[28] In addition, a major limitation of previous research in this area using administrative data have been hampered by the inability to confirm that the eye that had the RD was the same eye that underwent cataract surgery.[1,3,5,6] We manually validated all potential cases of RD using chart review and can be confident in not only the details of the complication but also those of the associated surgery.

Long-term follow-up of cataract surgery outcomes on a population-based level is lacking. We found the cumulative incidence of RD after phacoemulsification continued to increase up to 10 years following surgery. One population-based study with a significant follow-up (>20yrs) by Erie et al reported the cumulative incidence of RD after ECCE (including phacoemulsification) was 0.71% at 5 years and 1.23% at 10 years for all surgeries performed between 1980 and 2004 for all residents of Olmstead County, Minnesota.[2] While their cohort included ECCE, they reported no significant difference in the probability of RD compared to phacoemulsification. In contrast, the risk of RD in our study is substantially lower than reported by these authors (cumulative incidence 0.47% and 0.68% at 5 and 10 years respectively) and may be due to the later time frame of our study.

Less than 1% of cataract operations in our cohort involved an anterior vitrectomy and in 0.66% an IOL failed to be inserted. Anterior vitrectomy is generally only performed in cataract surgery where a posterior capsule (PC) rupture has occurred with vitreous loss. Failure to insert an IOL similarly would occur in situations of complicated surgery where capsule support is compromised. Both events could be regarded as a surrogate marker for complicated surgery involving PC rupture and vitreous loss. While we were unable to confirm every case of PC rupture that occurred, the data provided for this study did allow us to identify every case of anterior vitrectomy. Our rate of anterior vitrectomy during cataract surgery is within the range of other contemporary reports.[29,30] The 5-year cumulative incidence of RD after phacoemulsification where anterior vitrectomy was performed was 8.3% in our study, with a relative risk approaching 30-times higher than operations where no anterior vitrectomy was performed. Most studies report a similar, though not of such magnitude, increased risk of RD after operations associated with PC rupture ± vitreous loss of between 4.5 - 19.9 times,[2,6,11,15-17,31] although a few have reported no change in risk.[1,4,32] These findings highlight the importance of close follow-up of patients whose cataract operation has been complicated by PC rupture since there is a significant risk of RD that may extend many years after surgery.

Interestingly, we observed the incidence of RD to fall towards the end of the study period while the incidence of anterior vitrectomy remained constant. This may indicate that complicated procedures were being managed better and thus the risk of subsequent RD was less despite the need for anterior vitrectomy. However, the longer lead time to developing a RD means a number of cases would not have occurred by the end of the study period and thus not be counted.

We confirm the findings of previous large studies of RD after cataract surgery that younger age and male sex are significant risk factors for RD.[1,2,8] Patients < 60 years old undergoing phacoemulsification were almost 4-times more likely to have a RD compared to those who were ≥ 60 years old. The increased risk in younger patients is well established in the literature with most previous studies reporting similar findings to ours.[1-3,11] Several theories have been postulated regarding why younger patients are more likely to experience RD following phacoemulsification. The first relates to vitreous changes after cataract surgery. Rippandelli et al found that posterior vitreous detachment (PVD) occurred in 75.8% of patients following cataract surgery without a history of PVD or lattice degeneration.[14] Given 10-15% of PVD is associated with a retinal tear, then older patients may be protected from PVD since they are more likely to have already had phakic PVD, which tends to occur from 60 years onwards.[13,33] Younger eyes are also more likely to be abnormal in their development of cataract (e.g. traumatic cataract) and this abnormality may predispose these eyes to pseudophakic RD.

Males undergoing phacoemulsification were almost twice as likely to have a RD compared to females. The increased risk of RD in males has been widely reported elsewhere.[1] Sheu et al reported males had a risk of RD after phacoemulsification that was 2.43-times higher than in females in a similar population-based cohort.[1] While males in our study were younger on average than females, the difference remained after adjusting for age. Gender differences in the anatomy of the eye and vitreous have been postulated as potential contributing factors. Males tend to have a longer axial length,[34] while females tend towards earlier posterior vitreous detachment.[35] This may confer a protective effect on females for subsequent retinal detachment after cataract surgery. Males may also be more likely to suffer traumatic injury or engage in activities where eye trauma is more likely owing to their occupation or lifestyle, thus placing them at higher risk for pseudophakic retinal detachment.

There are some limitations to our study. Since all RDs in our study were identified based upon re-admission to hospital for surgery we have likely underestimated the true number of cases in the population. In WA the standard practice for the vast majority of RDs over the study period was for repair as an inpatient procedure. Procedures that may be performed in an outpatient setting (e.g. pneumatic retinopexy), and thus not captured, were non-standard and rarely practiced. Even so, not all patients with RDs will undergo surgery (e.g the patient may refuse further surgery) or they may have a RD treated outside of WA and as such would not be captured. The authors do feel that this number is likely to be small and thus any resultant bias minimal.

Other important risk factors for RD after cataract surgery identified in other studies include axial length and use of Nd:YAG posterior capsulotomy. Axial length ≥ 25mm has been significantly associated with an increased relative risk of RD after cataract surgery that approaches 6 times that of eyes with shorter axial lengths.[12,13] Ninn-Pedersen and Bauer found in their population-based study that for every 1mm increase in axial myopia the associated relative risk for RD was 1.3.[4] Similarly, Nd:YAG laser posterior capsulotomy was associated with an increase in risk of RD with a relative risk of 4.88.[4] Unfortunately, it was not possible to analyze these factors in our study since neither are recorded in the HMDC.

The strength of our study lies in its population-based design that involves a widely representative population, identifies the majority of complications, and covers 12 years. There are limitations surrounding the use of routinely collected administrative data in clinical research whose main purpose is not for clinical research.[36] The accuracy of such administrative data is dependent upon the quality of data processes and systems that create these databases. However, the WA data linkage system is a well established and validated resource that has been used extensively in population-based health research.[27,37] We have further added to the quality of data in our study through careful validation of RD using chart review.

In conclusion, the population-based incidence of pseudophakic RD has declined markedly since the adoption of phacoemulsification cataract surgery in WA. We confirm older age and male sex as important risk factors for subsequent retinal detachment identified in previous studies. Complicated operations necessitating anterior vitrectomy are at a significantly increased risk. Knowledge regarding the importance of such risk factors is important for clinicians in guiding patient preoperative counseling and postoperative review.

References

1. Sheu SJ, Ger LP, Chen JF. Male sex as a risk factor for pseudophakic retinal detachment after cataract extraction in taiwanese adults. *Ophthalmology.* 2007;114(10):1898-1903.

2. Erie JC, Raecker MA, Baratz KH, Schleck CD, Burke JP, Robertson DM. Risk of retinal detachment after cataract extraction, 1980-2004: a population-based study. *Ophthalmology.* 2006;113(11):2026-2032.

3. Norregaard JC, Thoning H, Andersen TF, Bernth-Petersen P, Javitt JC, Anderson GF. Risk of retinal detachment following cataract extraction: results from the International Cataract Surgery Outcomes Study. *Br J Ophthalmol.* 1996;80(8):689-693.

4. Ninn-Pedersen K, Bauer B. Cataract patients in a defined Swedish population, 1986 to 1990. V. Postoperative retinal detachments. *Arch Ophthalmol.* 1996;114(4):382-386.

5. Javitt JC, Street DA, Tielsch JM, et al. National outcomes of cataract extraction. Retinal detachment and endophthalmitis after outpatient cataract surgery. Cataract Patient Outcomes Research Team. *Ophthalmology.* 1994;101(1):100-105; discussion 106.

6. Javitt JC, Vitale S, Canner JK, Krakauer H, McBean AM, Sommer A. National outcomes of cataract extraction. I. Retinal detachment after inpatient surgery. *Ophthalmology.* 1991;98(6):895-902.

7. Olsen G, Olson RJ. Update on a long-term, prospective study of capsulotomy and retinal detachment rates after cataract surgery. *J Cataract Refract Surg.* 2000;26(7):1017-1021.

8. Boberg-Ans G, Henning V, Villumsen J, la Cour M. Longterm incidence of rhegmatogenous retinal detachment and survival in a defined population undergoing standardized phacoemulsification surgery. *Acta Ophthalmol Scand.* 2006;84(5):613-618.

9. Russell M, Gaskin B, Russell D, Polkinghorne PJ. Pseudophakic retinal detachment after phacoemulsification cataract surgery - Ten-year retrospective review. *J Cataract Refract Surg.* 2006;32(3):442-445.

10. Ozbek Z, Saatci AO, Durak I, Gunenc U, Kaynak S. Phacoemulisification and intraocular lens implantation in eyes with long axial length. *Annals of Ophthalmology.* 2007;39(3):217-221.

11. Szijarto Z, Schvoller M, Poto L, Kuhn F, Kovacs B. Pseudophakic retinal detachment after Phacoemulsification. *Annals of Ophthalmology.* 2007;39(2):134-139.

12. Sheu SJ, Ger LP, Ho WL. Late Increased Risk of Retinal Detachment after Cataract Extraction. *Am J Ophthalmol.* 2009.

13. Lois N, Wong D. Pseudophakic retinal detachment. *Surv Ophthalmol.* 2003;48(5):467-487.

14. Ripandelli G, Coppe AM, Parisi V, et al. Posterior vitreous detachment and retinal detachment after cataract surgery. *Ophthalmology.* 2007;114(4):692-697.

15. Chitkara DK, Smerdon DL. Risk factors, complications, and results in extracapsular cataract extraction. *J Cataract Refract Surg.* 1997;23(4):570-574.

16. Tuft SJ, Minassian D, Sullivan P. Risk factors for retinal detachment after cataract surger - A case-control study. *Ophthalmology.* 2006;113(4):650-656.

17. Desai P, Minassian DC, Reidy A. National cataract surgery survey 1997-8: a report of the results of the clinical outcomes. *Br J Ophthalmol.* 1999;83(12):1336-1340.

18. Monica ML, Long DA. Nine-year safety with self-sealing corneal tunnel incision in clear cornea cataract surgery. *Ophthalmology.* 2005;112(6):985-986.

19. Bhagat N, Nissirios N, Potdevin L, et al. Complications in resident-performed phacoemulsification cataract surgery at New Jersey Medical School. *Br J Ophthalmol.* 2007;91(10):1315-1317.

20. Naeser K, Baggesen K, Knudsen EB. Retinal detachment following intracapsular cataract extraction. A 10-year follow-up study. *Acta Ophthalmol Scand.* 1998;76(6):727-730.

21. Nielsen NE, Naeser K. Epidemiology of Retinal-Detachment Following Extracapsular Cataract-Extraction - a Follow-up-Study with an Analysis of Risk-Factors. *J Cataract Refract Surg.* 1993;19(6):675-680.

22. Clark A, Morlet N, Ng JQ, Preen DB, Semmens JB. Whole Population Trends in Complications of Cataract Surgery over 22 Years in Western Australia. *Ophthalmology.* 2011;118(6):1055-1061.

23. Semmens JB, Li J, Morlet N, Ng J. Trends in cataract surgery and postoperative endophthalmitis in Western Australia (1980-1998): the Endophthalmitis Population Study of Western Australia. *Clin Experiment Ophthalmol.* 2003;31(3):213-219.

24. Holman CD, Bass AJ, Rouse IL, Hobbs MS. Population-based linkage of health records in Western Australia: development of a health services research linked database. *Aust N Z J Public Health.* 1999;23(5):453-459.

25. National Coding Centre. *International Classification of Diseases, 9th Revision Australian Clinical Modifications (ICD9-CM)*. Sydney: National Coding Centre, University of Sydney; 1995.

26. National Centre for Classification in Health. *International Classification of Diseases, 10th Revision, Australian Modification (ICD-10-AM)*. Sydney: National Centre for Classification in Health; 2000.

27. Hall SE, Holman CD, Finn J, Semmens JB. Improving the evidence base for promoting quality and equity of surgical care using population-based linkage of administrative health records. *Int J Qual Health Care.* 2005;17(5):415-420.

28. Clark A, Preen DB, Ng JQ, Semmens JB, Holman CD. Is Western Australia representative of other Australian States and Territories in terms of key socio-demographic and health economic indicators? *Aust Health Rev.* 2010;34(2):210-215.

29. Jaycock P, Johnston RL, Taylor H, et al. The Cataract National Dataset electronic multi-centre audit of 55 567 operations: updating benchmark standards of care in the United Kingdom and internationally. *Eye.* 2009;23(1):38.

30. Zaidi FH, Corbett MC, Burton BJ, Bloom PA. Raising the benchmark for the 21st century--the 1000 cataract operations audit and survey: outcomes, consultant-supervised training and sourcing NHS choice. *Br J Ophthalmol.* 2007;91(6):731-736.

31. Jakobsson G, Montan P, Zetterberg M, Stenevi U, Behndig A, Lundstrom M. Capsule complication during cataract surgery: Retinal detachment after cataract surgery with capsule complication: Swedish Capsule Rupture Study Group report 4. *J Cataract Refract Surg.* 2009;35(10):1699-1705.

32. Smith PW, Stark WJ, Maumenee AE, et al. Retinal detachment after extracapsular cataract extraction with posterior chamber intraocular lens. *Ophthalmology.* 1987;94(5):495-504.

33. Coppe AM, Lapucci G. Posterior vitreous detachment and retinal detachment following cataract extraction. *Curr Opin Ophthalmol.* 2008;19(3):239-242.

34. Fotedar R, Wang JJ, Burlutsky G, et al. Distribution of Axial Length and Ocular Biometry Measured Using Partial Coherence Laser Interferometry (IOL Master) in an Older White Population. *Ophthalmology.* 2010;117(3):417-423.

35. Hayreh SS, Jonas JB. Posterior vitreous detachment: clinical correlations. *Ophthalmologica.* 2004;218(5):333-343.

36. Iezzoni LI. Assessing quality using administrative data. *Ann Intern Med.* 1997;127(8 Pt 2):666-674.

37. Kelman CW, Bass AJ, Holman CD. Research use of linked health data--a best practice protocol. *Aust N Z J Public Health.* 2002;26(3):251-255.

Figure legends

Figure 1: The trend in (a) crude incidence of retinal detachment and the (b) 12-year cumulative incidence in a cohort of 65,055 phacoemulsification cataract operations in Western Australia 1989 - 2001.

Figure 2: Comparison of the cumulative incidence of retinal detachment by (a) age, (b) gender, (c) year of surgery and (d) whether anterior vitrectomy was performed during surgery in a cohort of 65,055 phacoemulsification cataract operations in Western Australia 1989 - 2001 (Logrank $P<0.001$ for all graphs)

Figure 3: Comparison of the crude incidence of retinal detachment and anterior vitrectomy after 65,055 phacoemulsification cataract operations in Western Australia 1989 – 2001.

Table 1: Characteristics of patients undergoing phacoemulsification cataract surgery and a Cox proportional hazards regression model analyzing risk factors for retinal detachment after phacoemulsification in Western Australia 1989 - 2001.

	Phaco cohort (n=65,055)		Retinal detachments (n=237)		5 yr. Cumulative incidence		Univariate model			Multivariate model					
										All variables			Backwards stepwise variable selection		
	n	(%)	n	(%)	%	(95%CI)	HR	(95%CI)	P	HR	(95%CI)	P	HR	(95%CI)	P
Year															
1989 - 1993	3,974	(6.11)	49	(1.23)	0.96	(0.70-1.32)	1.00			1.00			1.00		
1994 - 1998	28,345	(43.57)	123	(0.43)	0.43	(0.36-0.51)	0.45	(0.31-0.63)	< 0.001	0.48	(0.32-0.71)	< 0.001	0.46	(0.32-0.66)	< 0.001
1999 - 2001*	32,736	(50.32)	65	(0.2)	0.25	(0.19-0.33)	0.41	(0.27-0.62)	< 0.001	0.45	(0.28-0.73)	0.001	0.43	(0.28-0.66)	< 0.001
Age															
80 +	1,858	(2.86)	33	(1.78)	0.11	(0.07-0.18)	1.00			1.00			1.00		
70 - 79	4,052	(6.23)	43	(1.06)	0.33	(0.26-0.42)	2.42	(1.49-3.92)	< 0.001	2.36	(1.45-3.85)	0.594	2.35	(1.45 - 3.83)	0.001
60 - 69	11,233	(17.27)	64	(0.57)	0.75	(0.57-0.98)	5.06	(3.09-8.28)	< 0.001	4.28	(2.58-7.10)	0.001	4.38	(2.67 - 7.19)	< 0.001
50 - 59	28,800	(44.27)	75	(0.26)	1.51	(1.09-2.09)	9.59	(5.69-16.16)	< 0.001	8.25	(4.79-14.23)	< 0.001	8.65	(5.10 - 14.68)	< 0.001
< 50	19,112	(29.38)	22	(0.12)	1.99	(1.32-2.99)	13.08	(7.43-23.04)	< 0.001	9.46	(5.13-17.41)	< 0.001	10.21	(5.71 - 18.25)	< 0.001
Gender															
Female	37,991	(58.4)	89	(0.23)	0.30	(0.24-0.38)	1.00			1.00			1.00		
Male	27,064	(41.6)	148	(0.55)	0.70	(0.58-0.83)	2.37	(1.81-3.10)	< 0.001	1.91	(1.45-2.51)	< 0.001	1.91	(1.46-2.51)	< 0.001
Failed IOL															
No	64,623	(99.34)	226	(0.35)	1.70	(0.81-3.54)	1.00			1.00					
Yes	432	(0.66)	11	(2.55)	0.46	(0.40-0.53)	4.86	(2.57-9.20)	< 0.001	2.28	(1.06-4.93)	0.036			
Anterior Vitrectomy															
No	64,412	(99.01)	189	(0.29)	0.39	(0.33-0.46)	1.00			1.00			1.00		
Yes	643	(0.99)	48	(7.47)	8.31	(6.14-11.20)	26.90	(19.40-37.24)	< 0.001	27.60	(19.27-39.52)	< 0.001	28.96	(20.43-41.05)	< 0.001
Patient locality															
Metropolitan	54,565	(83.88)	183	(0.34)	0.44	(0.37-0.52)	1.00			1.00					
Rural/Remote	10,254	(15.76)	52	(0.51)	0.61	(0.45-0.84)	1.52	(1.12-2.08)	0.008	1.33	(0.89-1.96)	0.160			
Not Classified	236	(0.36)	2	(0.85)											
Patient Insurance															
Public	23,499	(36.12)	73	(0.31)	0.41	(0.32-0.52)	1.00			1.00					
Private	41,548	(63.86)	163	(0.39)	0.49	(0.4 -0.58)	1.14	(0.86-1.51)	0.371	0.80	(0.42-1.54)	0.506			
Other	8	(0.01)	1	(12.5)											
Hospital type															
Public	23,416	(35.99)	77	(0.33)	0.42	(0.33-0.54	1.00			1.00					
Private	41,640	(64.01)	160	(0.38)	0.49	(0.41-0.58)	1.13	(0.86-1.48)	0.397	1.57	(0.79-3.10)	0.198			
Hospital location															
Metropolitan	58,614	(90.1)	214	(0.37)	0.47	(0.40-0.54)	1.00			1.00					
Rural/Remote	6,419	(9.87)	23	(0.36)	0.46	(0.30-0.71)	1.08	(0.70-1.66)	0.728	0.77	(0.40-1.46)	0.422			
Hospital volume															
>10,000 (n=2)	24,655	(37.9)	114	(0.46)	0.55	(0.45-0.67)	1.00			1.00					
2,000 to 5,000 (n=9)	24,739	(38.03)	71	(0.29)	0.37	(0.28-0.47)	0.72	(0.53-0.97)	0.031	0.75	(0.49-1.14)	0.176			
500 to 1,999 (n=12)	12,513	(19.23)	34	(0.27)	0.37	(0.26-0.54)	0.77	(0.52-1.13)	0.187	0.93	(0.60-1.45)	0.757			
<500 (n=23)	3,148	(4.84)	18	(0.57)	0.72	(0.43-1.21)	1.51	(0.92-2.49)	0.106	1.66	(0.88-3.12)	0.115			
Length of stay															
Day case	42,690	(65.62)	130	(0.3)	0.44	(0.36-0.54)	1.00			1.00					
Overnight	11,311	(17.39)	46	(0.41)	0.47	(0.34-0.65)	1.13	(0.80-1.59)	0.497	0.97	(0.67-1.39)	0.856			
>1 day	11,054	(16.99)	61	(0.55)	0.53	(0.41-0.70)	1.18	(0.86-1.62)	0.304	0.95	(0.67-1.37)	0.797			

*Cumulative incidence at 3 years