CLINICAL SCIENCE

Five year incidence of cataract surgery: the Blue Mountains Eye Study

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Aims: To assess the 5 year incidence of cataract surgery in an older population based prospective cohort.

Methods: 5 Year prospective follow up of the population based Blue Mountains Eye Study (BMES) performed in 1992. The follow up study examined 2335 survivors (75.1%) of the 3654 baseline participants. Baseline and 5 year slit lamp and retroillumination lens photographs were graded for presence of cortical, nuclear, or posterior subcapsular cataract using the Wisconsin cataract grading method and cataract surgery was documented from the history and the clinical examination.

Results: An overall cataract surgery rate of 5.7% in first or both eyes was documented. The incidence was 0.3% in people aged 49–54 years at baseline, 1.7% for ages 55–64 years, 7.9% for ages 65 to 74 years, and 17.4% in people aged 75 years or older. The rate of surgery in first or both eyes was 6.0% in women and 5.2% in men, age adjusted p = 0.66. Bilateral cataract surgery was performed during follow up on 2.7% of participants, while 43.1% of unilateral phakic cases had second eye surgery. Presence of any posterior subcapsular (PSC) cataract, either alone or in combination with other cataract types, was the most likely type of cataract at baseline to be associated with incident cataract surgery. Baseline age was the most important non-ocular variable predicting incident cataract surgery.

Conclusions: This study has documented age specific rates for 5 year incident cataract surgery in an older community. The finding of relatively similar incidence rates and ocular predictors of cataract surgery to those reported by the Beaver Dam Eye Study, Wisconsin, United States, is of interest, given previous documented similarities between these two populations.

Cataract is the most common eye disease of elderly people and is a major cause of visual impairment and blindness worldwide.[1] Cataract surgery is the most common surgical procedure in the population aged over 65 years. Detailed incidence data regarding cataract surgery are important in determining community surgical needs and in assessing the potential impacts of intervention strategies. Although there have been a number of clinic based incidence reports,[2–7] only two previous population based incidence studies of cataract surgery have been reported—the Beaver Dam Eye Study (BDES)[8] and the Barbados Eye Study.[9]

The same cataract grading method[10] was used in conducting the BDES and the Blue Mountains Eye Study (BMES), with these two studies reporting relatively similar age specific prevalence rates for the three principal types of age related cataract.[11 12] Other reports have documented the similarities in a number of common eye conditions between these two studies of largely white, northern European derived, older communities, including prevalence of reduced visual acuity,[13 14] age related maculopathy,[15 16] and open angle glaucoma.[17 18] The purpose of the current report is to assess the 5 year incidence of cataract surgery in the BMES cohort and to compare these findings with previous published data from the BDES.

METHODS

The BMES is a population based survey of vision and common eye diseases in an urban population aged 49 years or older. Participants were resident in two postcode areas in the Blue Mountains region, west of Sydney, Australia. The baseline survey methods and procedures have been previously described.[14 16] The study was approved by the Western Sydney Area Health Service human ethics committee and signed informed consent was obtained from all participants. A detailed questionnaire was administered, participants underwent a comprehensive eye examination after pupil dilatation and were asked to return for fasting blood tests, including glucose. Baseline examinations were performed during 1992–4, when 3654 of the 4433 (82.4%) eligible residents were examined.

Five year follow up examinations were conducted during 1997–9. Of the 3654 residents seen at baseline, 543 had died by the time of the 5 year follow up examinations and 2335 (75.1% of the survivors) were re-examined. The mean duration between examinations was 5.1 (SD 0.6) years. Of those not seen, 382 (12.3%) had moved from the area and 394 (12.7%) refused the examination. Those who returned for follow up were younger than those who did not return (mean age 64.3 *v* 65.6 years), were less likely to be female (57.2% *v* 61.1%), and were also less likely to have had previous cataract surgery (3.8% *v* 6.5%).

At both examinations, cataract was documented from both slit lamp (Topcon SL-7e camera, Topcon Optical Co, Tokyo, Japan) and retroillumination (Neitz CT-R cataract camera, Neitz Instrument Co, Tokyo, Japan) lens photographs. Details of the photographic technique and grading[12 16] used in the BMES have been previously reported. The grading closely followed the Wisconsin cataract grading system,[10] with good agreement found for assessments of both intergrader and intragrader reliability.[19] A history of past cataract surgery was taken and confirmed at both examinations and from the photographic grading. Presence and severity of nuclear, cortical, and posterior subcapsular (PSC) cataract was assessed for each eye.[10] Nuclear cataract was defined on a five level scale by comparison with a set of four standard slit lamp photographs; for this study, level four or five was defined as nuclear cataract. The percentage area involved by cortical or PSC cataract in each eye was calculated from the estimated percentage area involvement in each of nine segments of the lens divided by a grid.[10] For this study, cataract was considered present at baseline if the nuclear opacity was grade 4 or greater, if cortical

Table 1 Comparison of 5 year incident cataract surgery rates between the Blue Mountains Eye Study (BMES) and the Beaver Dam Eye Study (BDES)

	Eyes at risk BMES	Surgical cases BMES	Incidence % (95% CI) BMES	BDES
Total				
49–54	328	1	0.3 (0.0 to 0.9)	0.8*
55–64	824	14	1.7 (0.8 to 2.6)	3.0*
65–74	784	62	7.9 (6.0 to 9.8)	12.2*
75+	282	49	17.4 (12.9 to 21.8)	19.8*
total	2218	126	5.7 (4.7 to 6.6)	6.3
Women				
49–54	180	0	0	
55–64	467	10	2.1 (0.8 to 3.5)	
65–74	456	39	8.6 (5.9 to 11.1)	
75+	174	28	16.1 (10.6 to 21.6)	
total	1277	77	6.0 (4.7 to 7.3)	
Men				
49–54	148	1	0.7 (0.0 to 2.0)	
55–64	357	4	1.1 (0.2 to 2.2)	
65–74	328	23	7.0 (4.3 to 9.8)	
75+	108	21	19.4 (11.7 to 26.8)	
total	941	49	5.2 (3.8 to 6.6)	

*Estimated from Klein *et al*[8]

Table 2 Five year crude and age standardised incidence (%) of cataract surgery in right eyes of participants attending the Blue Mountains Eye Study (BMES) and the Beaver Dam Eye Study (BDES) by baseline cataract type

		5 Year cataract surgery incidence			
		BMES			
Cataract type	Status	Eyes at risk	Crude (%) (95% CI)	Standardised* (%)	BDES (%)
Only cortical	absent	1200	1.1 (0.5 to 1.7)	1.5	1.3
	present	140	7.1 (2.8 to 11.5)	6.7	9.0
Any cortical	absent	1901	3.0 (2.2 to 3.7)	3.5	3.1
	present	276	13.0 (9.1 to 17.0)	10.1	17.2
Only nuclear	absent	1200	1.1 (0.5 to 1.7)	1.5	1.3
	present	180	8.9 (4.7 to 13.1)	5.6	9.0
Any Nuclear	absent	1388	1.9 (1.2 to 2.7)	2.4	2.6
	present	235	14.0 (9.6 to 18.5)	8.9	32.0
Only PSC	absent	1200	1.1 (0.5 to 1.7)	1.5	1.3
	present	36	11.1 (0.3 to 21.9)	13.7	16.0
Any PSC	absent	2107	3.7 (2.9 to 4.5)	3.9	3.4
	present	70	21.4 (11.6 to 31.3)	16.4	28.0

*BMES data age standardised to BDES population.

Table 3 5 Year risk of incident cataract surgery in the right eyes associated with baseline cataract type

Variable (baseline)	Odds ratio* (95% CI)
Nuclear cataract	4.2 (2.3 to 7.6)
PSC cataract	5.8 (2.4 to 13.9)
Cortical cataract	2.3 (1.3 to 4.4)

*Simultaneously adjusted for each type of cataract, age, and sex.

opacity involved ≥5 % of the total lens area or if any PSC cataract was present, as in the BDES.[11]

Because age is strongly associated with cataract incidence[20] and as both higher prevalence[11 12 21–23] and incidence[9 20] of some types of cataract have been reported in women, all odds ratios are age and sex adjusted, unless otherwise stated. Cataract surgery in first or both eyes refers to participants with two phakic eyes at baseline who had cataract surgery in at least one eye during the 5 year follow up period. Cataract surgery in the second eye describes participants with cataract surgery in one eye at baseline and in both eyes at follow up and cataract surgery in any eye combines both of the above groups. The grading of age related maculopathy lesions closely followed that in the BDES, as previously described.[16]

Baseline refraction data were used for analyses of refractive error. The baseline refractive state was defined as the spherical equivalent refraction (SER), calculated by the algebraic addition of the best corrected spherical refraction and half the cylindrical refraction. Emmetropia was defined as SER between +1.0 and −1.0 D, hyperopia as >+1.0 D and myopia as <−1.0D.

The statistical analysis system (SAS, version 6.12 for Windows; SAS Institute, Cary, NY, USA) was used for statistical analyses including χ^2 test, Mantel-Haenszel test for trend and logistic regression. Multiple logistic regression analysis

Table 4 Comparison of the age adjusted rates of cataract surgery between the Blue Mountains Eye Study (BMES), Beaver Dam Eye Study (BDES) and various baseline ocular characteristics

Characteristic	BMEs incidence	p Value*	BDEs incidence	p Value*
ARM				
none	4.6	0.4	3.5	0.08
early	3.4		6.5	
late	0		1.1	
Refractive error				
myopia	13.1	0.001	7.8	<0.0001
emmetropia	4.5		4.1	
hyperopia	3.3		3.1	
IOP (mm Hg)				
<14	3.6	0.3	3.2	<0.01
14–15	5.3		3.7	
16–17	3.7		4.9	
>18	5.3		5.5	
Corrected visual acuity				
not impaired	4.0	<0.001	2.7	<0.0001
impaired ≤6/12	18.6		20.1	

*p value for trend.

was employed to calculate adjusted odds ratios (OR). A p value of less than 0.05 was used to indicate statistical significance. Age standardisation was performed by the direct method.

RESULTS

Of the 2335 people examined at the 5 year follow up, 117 (5.0%) had previous cataract surgery in one or both eyes and were excluded. Of the remaining 2218 people at risk for cataract surgery in their first or both eyes, 126 (5.7%) underwent cataract surgery during the follow up period. At the 5 year examination, in addition to the 126 who had incident cataract surgery, 1012 people had cataract present in one or both eyes (45.6%), 879 (396%) had no cataract present, and 201 (9.1%) had an incomplete set of gradable photographs.

Table 1 shows that the incidence of cataract surgery in first or both eyes increased from 0.3% (one case) in people aged 49–54 years at baseline to 17.4% (49 cases) among those aged 75 years or older, sex adjusted OR 3.3 per decade (95% CI 2.6 to 4.3). Cataract surgery was performed in both eyes of 58 participants (2.7%) and in the second eye of 24 participants (43.1%), who were unilaterally phakic at baseline. Incident cataract surgery was higher in women (6.0%, 77 cases) than in men (5.2%, 49 cases), with female rates higher in all younger age brackets than age 75 years or older. This difference, however, was not statistically significant, age adjusted OR 1.1 (95% CI 0.7–1.6) Among all incident cataract surgical cases, 88.1% were performed in people aged 65 years or older at baseline.

Table 1 compares incident cataract surgery rates (either eye) for the BMES and BDES. At all ages, the 5 year cataract surgery incidence was higher in the BDES, compared with BMES, with the differences greater in younger than in older age groups.

Table 2 presents age adjusted cataract surgery incidence by the presence of individual cataract types at the baseline examination, for both the BMES and the BDES. Categories of "any" cataract include eyes with one or more of the three types of lens opacity while the "only" categories include eyes with a single type of lens opacity. Across all types of cataract, lenses with "any" cataract had higher rates of cataract surgery than lenses with a single type of lens opacity. These comparison rates were similar for most cataract types, either alone or in combination. The largest discrepancy was for the presence of any nuclear cataract at baseline, with the BDES surgical incidence (32.0%) more than double the 5 year incidence found for BMES participants (14.0%).

Compared with other cataract types, people with PSC cataract, either alone or in combination, had the highest cataract surgery incidence (21.4%) in our study during the 5 year follow up period. Among people aged 75 years or older at baseline, 50.0% of right eyes with any PSC cataract at baseline underwent cataract surgery compared to 11.5% of eyes without any PSC cataract at baseline. The cataract surgery rate for eyes with any nuclear cataract at baseline (14.0%) was similar to the surgical rate in eyes with any cortical cataract present at baseline (13.0%).

Table 3 shows the 5 year risk of incident cataract surgery in the right eyes associated with the cataract type present at the baseline examination. The odds ratios for each cataract type were simultaneously adjusted for other types of cataract, as well as for age and sex. Baseline PSC cataract was associated with the highest (almost sixfold) cataract surgery risk (OR 5.8), that was unrelated to presence of other cataract types. Presence of nuclear cataract at baseline was associated with a higher 5 year risk of incident cataract surgery (OR 4.2) than presence of cortical cataract (OR 2.3).

Table 4 compares age adjusted 5 year cataract surgery incidence in the BMES and BDES by the presence of various baseline ocular characteristics. Presence of myopia was associated with a significantly higher cataract surgery incidence (13.1%, $p<0.001$) than either emmetropia (4.5%) or hyperopia (3.3%). We found no significant differences in the 5 year cataract surgery incidence in eyes with or without signs of age related maculopathy or with increasing intraocular pressure levels. However, the presence of visual impairment at baseline (best corrected visual acuity <20/40) was also associated with a significantly higher cataract surgery incidence (18.6%, $p<0.001$).

DISCUSSION

This study has provided age specific rates for 5 year incident cataract surgery in a representative older Australian urban community. Our study found similar age specific incidence to that reported from the comparable United States rural community of Beaver Dam, Wisconsin. Both communities had ready access to ophthalmic care; a single ophthalmologist practised full time in Beaver Dam, while in our region two ophthalmologists attended on a part-time basis.

In both studies, in both women and men, and for the three principal cataract types, increasing age was the most important predictor of incident cataract surgery.[8] Cataract reflects well described ageing processes in the lens. Our prevalence data[12] indicated that by the age of 80 years, 80% of participants either had significant cataract present in one or both eyes or had undergone cataract surgery.

Our study confirms previous clinical studies indicating that the presence of any PSC cataract at baseline is a highly significant ocular predictor of incident cataract surgery.[8] This may be because PSC cataract causes a significantly greater drop in reading acuity and may increase glare sensitivity more than other types of cataract. In younger patients with PSC cataract who may be still working, uncorrected presbyopia in conjunction with PSC cataract may combine to result in a greater effect on reading vision and may be perceived as a more significant impediment than among patients in older age groups.

Participants with any nuclear cataract at baseline included the highest number of cataract surgical cases, which partly reflects the much higher nuclear cataract prevalence than PSC cataract. Among non-mixed cataracts, however, PSC cataract remained the strongest predictor of cataract surgery, followed by nuclear and cortical cataract.

Women had a higher age adjusted 5 year incidence of cataract surgery in either eye as well as in first or both eyes. Although not statistically significant in our study, this trend was mirrored and was statistically significant in the BDES. It may reflect either differences in cataract prevalence[11 12 21–23] and incidence[9 20] between men and women or alternatively it could reflect a tendency for women to access health services earlier than men.

As expected, visual impairment at the baseline examination was a very strong predictor of incident cataract surgery during the 5 year follow up period. We were not able to measure the extent to which advice from the study investigators about the presence of cataract at the time of the baseline examinations may have influenced the rate of cataract surgery thereafter. Although it is likely that such information could have increased the cataract surgical rate, our advice regarding any need for surgery was extremely conservative and participants were asked to discuss any relevant findings in our report with their general practitioner. This bias could have led to a somewhat higher rate of cataract surgery in our study population than in a comparable general population. We did not, however, provide any referrals for consideration of cataract surgery

The presence of myopia at the baseline examination was also a significant risk for cataract surgery. This may reflect either a biological association between myopia and the development or progression of cataract or to the myopic shift well known to accompany the development of nuclear sclerosis. More frequent eye examinations because of refractive needs could also contribute to higher cataract surgery rates, together with the increasing practice of clear lens extraction for refractive purposes.

In some studies, lower socioeconomic status has been associated with higher prevalence of cataract and with lower incidence of cataract surgery. We recently reported these data from our cohort and found no significant socioeconomic predictors of incident cataract surgery.[24]

A strength of our study lies in its population based sampling frame that reduces bias in patient selection. Our findings, however, did not include people too sick or weak to attend the follow up study. A number of studies,[25–29] including our own,[30] have demonstrated that the presence of cataract or cataract extraction may be a risk factor for mortality. Thus, it is also possible that those who did not attend because of poor health may have had a higher rate of incident cataract and cataract surgery, so that we could have underestimated the true rate.

The use of identical methodologies in the BMES and the BDES has permitted a close comparison of incident cataract surgery findings between these two large studies. Although the BDES age specific rates for cataract surgery were higher than in the BMES, the age adjusted rates were closer, taking into account the presence of associated cataract (Table 2) and other ocular characteristics (Table 4). The ocular factors found to predict incident cataract surgery were also relatively similar between these two studies, as was the magnitude of increased risk associated with presence of individual types of baseline cataract.

The largest difference between the two studies was the impact of baseline nuclear cataract, which led to a substantially higher risk of incident surgery in the BDES than in our study, either alone or in combination with other cataract types. This could reflect the higher nuclear cataract prevalence reported from our study than in the BDES.[12] It could possibly also have been influenced by the random underexposure of around 30% of the nuclear cataract images in our baseline study, that we have previously discussed.[12 31] The relative consistency in findings between the BMES and the BDES lends support to the findings from both studies. Although not formally tested, these data also suggest that the Wisconsin cataract grading system is likely to have reasonable interstudy reproducibility. Reliability within our own study has previously been documented.[19]

There are important limitations in any attempt to extrapolate our findings to other communities. Both the BMES and BDES samples are largely derived from northern European migrants, so that racial variations in the rate of incident cataract could influence the need for cataract surgery in different communities.[9 28 32] Access to cataract surgery could also be reduced in areas of social disadvantage or in rural communities. These factors could lead to substantial regional variation in the incidence of cataract surgery.

In summary, this study provides data on the 5 year incidence and ocular predictors of cataract surgery from a representative older Australian community. Our population based findings may be useful in the future planning of cataract surgical services. Incidence data provide a measure of the ongoing requirements for cataract surgery while data on the prevalence of significant cataract associated with visual impairment describe only the backlog of surgical cases. Our current 10 year follow up of this cohort will permit an examination of factors that have a greater impact over the longer term.

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