# Round Table Discussion

## Cataract blindness – the African perspective

David Yorston[1] & Adenike Abiose[2]

Brian & Taylor (*1*) have provided a succinct and challenging account of the current state of our knowledge regarding the global elimination of cataract blindness. We would like to comment on their article from the perspective of ophthalmologists working in Africa, the continent with the lowest rate of cataract surgery.

The authors rightly draw attention to the practical difficulties of limiting exposure to UV light in a tropical agrarian society. However the problems of cataract prevention are even greater. Since cataract surgery in an industrialized country will cost between US$ 500 and US$ 2000, it makes good economic sense to delay or prevent cataract, if possible. In Africa the situation is different. Cataract surgery is much less expensive, costing about US$ 50–100 per operation. Under these circumstances it may be more cost-effective to provide cataract surgery for a relatively small number of patients, as opposed to providing long-term preventive treatment for the entire population. Despite this caveat, more could be done, particularly by limiting the use of tobacco and preventing diabetes-related cataract.

Although there are large numbers of African patients who need cataract surgery, few eye clinics in Africa have a formal surgical waiting list. This is because of barriers which restrict patients' access to eye care. Brian & Taylor remind us that these include the deterrent effect of patients who have had operations with poor outcomes. A population-based survey in KwaZulu-Natal showed that a campaign to increase cataract surgery had little effect on the prevalence of blindness, but shifted the etiology from cataract to uncorrected aphakia (*2*). A high priority for cataract surgery in Africa must be to make intraocular lens implantation a routine part of cataract surgery (*3*), and to encourage prospective monitoring of outcomes in order to improve surgical results (*4*). Further improvement can be achieved by ensuring that patients are refracted following surgery, and that they are provided with glasses to correct residual refractive error.

The cost of surgery may be a deterrent, but it is a small proportion of the total cost to the household, which includes travelling to the clinic, attending outpatient follow-up, days off work, and other expenses. If the total costs of cataract surgery are to be minimized, it will not be enough merely to subsidize the operation. Cataract surgery in Africa must become more "patient-friendly" — more convenient for both the patients and their families. This will require the active involvement of local communities in planning and developing eye services.

A third barrier is lack of awareness. This can be overcome by specially trained community workers who seek out cataract patients in their own homes and make arrangements for them to be transferred to hospital for surgery. These programmes are expensive, but have been very effective at increasing the numbers of cataract operations carried out (*5*). If the surgery is effective, the number of successfully treated patients in the community should provide sufficient testimony to convince the remainder to seek treatment. At that point the community-based programme will have completed its task. Health education may also have a role in raising community awareness.

Given the huge obstacles, is the elimination of cataract blindness in Africa by 2020 a realistic goal or merely a pious hope? We believe that the goals of Vision 2020 are achievable in Africa, and there are grounds for this optimism.

Firstly, the number of cataract operations is increasing rapidly in some countries. In Kenya, there were a little over 5000 cataract operations reported to the National Prevention of Blindness Committee in 1996. By 1999, this had increased to over 12 000. The quality of surgery may also be improving. The proportion of operations with a lens implant appears to be increasing, and more attention is being paid to improving the outcome of cataract surgery (*6*, *7*).

Secondly, human resources development is making cataract surgery more widely available. Many surgeons have been successfully trained or retrained in extracapsular cataract extraction and posterior chamber intraocular lens implantation through a series of short courses which have been held in most anglophone African countries (*7*). Community eye health training programmes have been set up in Ghana, Nigeria, South Africa and the United Republic of Tanzania, and these are already assisting eye surgeons to plan and develop eye services. Francophone and Portuguese-speaking Africa have fewer training programmes, but more are planned for the future.

As Brian & Taylor emphasize, the improvement in human resources has been matched by increased availability of low-cost materials such as intraocular lenses, sutures and microscopes. This has greatly improved the accessibility of high quality cataract surgery for many people. Do these improvements represent real progress in the villages? A recent population-based survey from the Gambia shows that the prevalence of blindness is falling, and that this is largely due to the successful management of cataract (*8*). The greatest challenge for ophthalmologists, policy-makers, donors, and researchers lies not in developing new techniques or treatments, but in ensuring that the high standards of both output

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and outcome that are currently manifest in a few centres become the norm throughout Africa. ■


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## Cataract genetics

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Brian & Taylor (*1*) provide a comprehensive overview of various potential strategies to prevent cataract blindness. This article will expand on their very interesting discussion of current knowledge regarding the genetics of age-related cataract, research to extend this knowledge, and ideas about how the knowledge might be translated into effective prevention strategies.

Epidemiological studies have provided some evidence for familial aggregation of lens opacities. McCarty et al., have reported that subjects with cortical cataract in a population-based study in Victoria, Australia, were nearly twice as likely as unaffected persons to have a sibling or parent with cataract. No such significant association was found for posterior subcapsular or nuclear cataract (*2*).

The Framingham Offspring Eye Study (*3*) reported a tripling of the odds ratio for nuclear sclerosis and posterior subcapsular cataract in subjects with a sibling with cataract. This study was not designed to distinguish between genetic and environmental factors underlying the clustering of lens opacities within families, but is consistent with the hypothesis that there is an inheritable component of risk for age-related cataract.

Heiba et al. (*4*) found highly significant correlations of age- and sex-adjusted nuclear cataract scores among 1247 individuals from 564 sibships in the Beaver Dam Eye Study. Under their model, the hypothesis of a Mendelian transmission of a major effect could not be rejected, but the hypothesis of a random environmental major effect was rejected. A single major gene could account for 35% of the total variability of adjusted measures of nuclear sclerotic cataract. Similar results were reported for the Beaver Dam population for cortical cataract, with up to 75% of variance among men potentially explained by a single major gene, assuming a sex-dependent variance (*5*).

The most direct evidence for a genetic effect in cataract has been provided by recently-appearing classical twin studies on nuclear (*6*) and cortical (*7*) cataract. Both studies examined 506 female Caucasian twin pairs (226 monozygotic, 280 dizygotic), among whom cortical and nuclear lens opacity were assessed using both subjective grading methods and computerized image analysis. A strong genetic effect was found in both studies: a heritability of 48% for nuclear cataract (as opposed to only 38% of the variance accounted for by age and 14% by environmental factors) (*6*), and 59% for cortical cataract (*7*).

While it would probably be erroneous to interpret these studies as suggesting that age-related cataract is controlled by a single gene in Mendelian fashion, studies which have attempted to quantify the impact of genetic factors on age-related cataract have been consistent with the hypothesis that a genetic effect exists. This evidence is suggestive, but to date no actual genes have been definitively shown to influence the development of primary age-related cataract, that is, cataract in the fifth decade and beyond, without associated ocular or systemic abnormalities. At least two broad strategies exist to identify such genes. The "candidate gene" approach seeks to identify mutations or sequence variants in well-characterized genes thought likely to be associated with age-related cataract, attempting to establish statistically significant associations between these variants and the presence of lens opacity. Most of the candidate genes currently being examined for an association with age-related cataract have been demonstrated to cause congenital cataract. Such candidate genes include those affecting crystallins (*8–12*), structural proteins (*13*), gap junction proteins (*14, 15*), and aquaporins (*16*).

Some investigators have also suggested that poorly functioning anti-oxidant enzymes are more likely to underlie age-related lens opacities (*17*). At least one such anti-oxidant enzyme, glutathione-S-transferase, has been examined for a possible association with age-related cataract, albeit with contradictory results. Sekine et al. (*18*) found a significantly higher frequency of deletion of the gene for glutathione-S-transferase, a key enzyme involved in free radical scavenging, among Japanese cataract patients as opposed to age-matched controls. The mean age of cataract patients with the gene deletion was significantly younger than for patients possessing the normal gene. Alberti and co-workers failed to replicate these results in an Italian population (*19*).

The other approach was has been used to identify genetic factors which cause or accelerate age-

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related lens opacity is the sibling-pair design. Both affected sib-pair analysis, in which both members of the sib pair have some degree of lens opacity, and general sib-pair analysis, in which lens opacity need not be present to gain analytic power, are possible. Both methods may be used to test for excess sharing of marker alleles between siblings throughout the genome, as a way to establish linkage between the observed markers and an unobserved susceptibility locus (*20*). Unlike the candidate gene approach, which requires a priori knowledge as to which genes are likely to be important, sib-pair methods can be used to identify "hot spots" in the genome where genes controlling age-related cataract are likely to reside. Recent statistical refinements (*21, 22*) make sib-pair methods a powerful tool to identify even multiple genes controlling complex traits such as non-insulin-dependent diabetes (*23*) and alcoholism (*24*). Ongoing studies are attempting to apply these methods to age-related cataract as well. ■


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## Cataract blindness — the Indian experience

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Efforts to tackle cataract blindness in India have been going on in earnest for the last three decades. The revolutionary idea of holding surgical eye camps in makeshift hospitals started in the late 1960s and was extremely popular until the early 1980s. These frequently used measures for bringing an eye care delivery system to the village level created awareness and interest in the target population. More importantly, the participation of the community leaders and quick access to a familiar location played an important part in ensuring the success of these camps.

In the early 1980s, Aravind Eye Hospital began changing this strategy by conducting screening eye camps to identify patients with cataract who could then be brought to the base hospital. Instead of a single large surgery camp, multiple smaller screening camps at a more grassroots level were conducted, with reduced infrastructure requirements. Surgeons were more comfortable operating in a fixed, familiar environment, and this resulted in better surgical quality and more cost effectiveness. A traditional intracapsular cataract extraction (ICCE) was performed and aphakic spectacles were provided during discharge. Brian & Taylor (*1*) have pointed to the effectiveness of the Aravind system.

The late 1980s saw the intraocular lense (IOL) becoming more popular in the affluent population of

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India. However, its widespread use was limited by cost constraints of the IOL and other consumables and by lack of adequately trained personnel. Around this time, the setting up of IOL manufacturing facilities like Aurolab in Madurai, India, and the Fred Hollows Foundation in Nepal and Eritrea helped produce high quality intraocular lenses at a fraction of the cost, thus making these devices affordable to the general population.

In the early 1990s, patients attending the free section of the Aravind Eye Hospital were offered a choice of free ICCE surgery or IOL surgery for which they would have to pay an equivalent of US$ 10. Information about the felt advantages of the IOL spread rapidly, and patients came to the hospital on their own asking for it. Apart from the advantage of patients sharing a significant part of their surgical costs, this process also reduced the cost and energy of case-finding, which could then be channelled into more productive activities. A retrospective analysis was made for the years 1992–94, to determine the rate of acceptance and affordability of IOL among the rural population of Tamil Nadu. The study estimated that the acceptance rate increased at an average of almost 70–100% as compared to a 17–20% increase in the total number of cataract operations performed per year (*2*).

Introduction of large-scale extracapsular cataract extraction with IOL implantation (ECCE/PC-IOL) sparked off a debate about the safety and efficacy of this new procedure as compared to the conventional ICCE. To answer these queries, the Madurai Intraocular Lens Study randomized 3400 cataract patients to receive either an ICCE or an ECCE with PC-IOL. After a follow-up period of one year, the study concluded that although both operative procedures were safe and effective for cataract patients with bilateral impairment, ECCE/PC-IOL was superior to ICCE in terms of both visual acuity restoration and safety (*3*). Moreover, in this developing country setting, ICCE and ECCE/PC-IOL were associated with substantial benefits in improved everyday vision function and patients who received ECCE/PC-IOL reported greater benefits and fewer problems with vision than did patients who received ICCE-AG (*4*).

A further four-year follow-up study (*5*) performed on patients who received ECCE/PC-IOL revealed that 13% of patients subsequently developed significant posterior capsular opacification. This showed that the need for laser capsulotomy may be less than anticipated on the basis of previous reports.

The training of eye surgeons in ECCE/PC-IOL received a major boost when Sight Savers started, an intensive eight-week training course, and to this date, 573 eye surgeons from all over India and 92 eye surgeons from 19 other developing countries have successfully completed this course and are well trained in performing IOL surgery.

So where do we go from here? Even after these many innovations, large numbers of patients are going without cataract surgery. Physical accessibility may be a problem in some remote mountainous terrain of North India, but may not be a problem in most other areas. Technological revolution is sweeping across this part of the world, with satellite television and Internet connecting even the most remote villages, so not knowing where to go may not be a major obstacle now. Perhaps, we are still not offering a product matching the expectation of the patient. Outcome studies conducted in China (*5*) and Nepal (*6*) have resulted in less than optimal visual outcomes and lessons should be learnt from them. Strategies have to be continually reassessed, and modified as necessary. Technological advance in other fields has raised the expectations of patients to new heights. How we meet these expectations by focusing on outcomes, which include not only visual acuity but also quality of life, is the question by which the future success of large-scale cataract surgery programmes will be judged. ■


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## Can cataracts be prevented?

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As pointed out by Brian & Taylor (*1*), the prevalence and incidence of cataract blindness in the developing world far surpasses the surgical services available to treat these patients. This situation will worsen in the future, as ageing of the world's population will further accelerate the incidence of cataract blindness.

A dramatic increase in the volume of quality surgical services is required to meet the needs of those already blind from cataracts. However, even if innovative programmes and methods can deliver these services, the ongoing and accelerated incidence of cataract will result in the continued growth of the untreated cataract blindness. Only by tackling the

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problem of cataract with *both* prevention *and* treatment can we hope to overcome the challenges ahead.

The risk factors for cataract development have been delineated by previous epidemiological studies. (*2, 3*) These risk factors are summarized in Table 1. They are ranked according to the strength of association with cataract development. Risk factors that are highly likely or generally believed to have a role in cataract development and are modifiable include: sunlight exposure, specifically ultraviolet-B (UV-B); deficiency in dietary antioxidants and protein; smoking; and diarrhoea with severe dehydration. Use of aspirin and consumption of alcohol could act as factors in cataract development, and are modifiable.

In order to assess our ability to prevent cataracts, research is needed. At present, there are few studies examining interventional strategies for prevention of cataract. Several studies examine the ability of antioxidant supplementation to decrease cataract formation, but only one of these is occurring in a developing country (*4–9*). The Antioxidants in Prevention of Cataract (APC) Study is a randomized, placebo-control, double blind clinical trail of vitamins A, C, and E, examining the impact of this vitamin combination on cataract progression in South India (*5*). The results of this study are likely to be generalizable to other tropical developing countries with diets deficient in antioxidants. There will be an interim analysis of the results of the APC Study after the Year 3 cataract grading in 2001.

Prospective evaluations of interventions to decrease people's ultraviolet exposure are important. This will probably be challenging. In order to change habits regarding sunlight exposure, cultural practices such as wearing certain types of hats and UV-B blocking glasses must be changed. This intervention has the potential to decrease cataract formation. However, studies are essential to assess the ability to evoke behavioural changes and then evaluate the subsequent impact on cataract formation. To our knowledge, no studies are being done currently in this area.

Most of the remaining risk factors (low protein intake, smoking, diarrhoea with severe dehydration, aspirin and alcohol use) can have a significant impact on general health. They are of concern not only for cataract prevention but for public health at large. Future prospective studies of cataract progression as part of larger public health interventions could provide important data on the impact of these interventions in developing countries.

Improvement in economic and educational status may have a positive impact on cataract prevention. The association of cataract development with low status in these areas probably means that these are markers for other risk factors.

Other interventions may provide ways to either treat or prevent cataract, for instance in the form of drug, nutritional, or genetic therapy. However, the time required for new therapies to go from the laboratory into widespread use in humans is usually several years.

It is to be hoped that ongoing studies will have positive results and plans can be made to implement the interventions concerned on a large scale. Additional studies are needed to provide data to determine which public health interventions can have the greatest impact on cataract prevention. As Brian & Taylor point out, to fully solve the problem of cataract blindness, an innovative approach that includes both surgical treatment of existing cataracts and preventive measures will be required. ■

Table 1. **Risk factors for developing cataracts** (refs *2, 3*)

| Risk factor and level of certainty | Whether modifiable in a way To prevent cataract |
|---|---|
| **Generally accepted** | |
| Age | No |
| Trauma* | Possibly |
| Intraocular inflammation* | Possibly |
| Diabetes mellitus | Uncertain |
| Sunlight (UV-B) exposure | Yes |
| Corticosteroid use | Probably not significantly |
| **Highly likely** | |
| Dietary protein deficiency | Yes |
| Dietary antioxidant deficiency | Yes |
| Smoking | Yes |
| Diarrhoea/dehydration | Yes |
| Low socioeconomic class/education** | Unknown |
| **Uncertain** | |
| Alcohol | Yes |
| Aspirin | Yes |
| Family History | No (possible role of genetic therapy?) |
| Hypertension | Possibly |

*Not responsible for a significant percentage of cataract blindness.

**Probably a marker for multiple risk factors.


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