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Cataract

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Epidemiology

Today there are about 45 million blind people in the world, and this total is rising, as the world's population both ages and increases. Ninety per cent live in the poor countries of Asia, Africa and Latin America, where over half of the blindness is due to cataract. The World Health Organization (WHO) estimated that in 1995 there were 17 million people suffering from blindness caused by cataract – today the figure is even higher.

Cataract blindness is more common in India and Africa than in Australia; it is more common in women, in people with low incomes, and in rural populations. At present there is little data on the incidence of cataract blindness in developing countries. A cohort study from India suggested an incidence of nearly five people per thousand in 1986[1] in one district, but it is not known whether this estimate is representative for entire India or for other countries. A high prevalence of cataract blindness may be due to either an increased incidence, or a reduced rate of cataract surgery or both.

Risk factors

Case–control studies have shown that there are several factors associated with a higher risk of cataract[2] (Box 1). These studies require careful interpretation, as the risk factors for nuclear, cortical or posterior sub-capsular lens opacities are almost certainly different. A factor associated with an increased incidence of nuclear cataract may have little effect on the risk of posterior sub-capsular lens opacity.

Prevention

At present few of the risk factors for cataract are easily modifiable. Patients who smoke should be advised to stop, and diabetics should maintain tight control of their blood sugar. However, although it is theoretically possible to reduce ultraviolet (UV) light exposure by wearing UV-absorbent sunglasses, this is unlikely to be a practical intervention on a global scale. In addition, there is no evidence that vitamin supplements have any effect on cataract formation. An increased understanding of the genetic factors underlying cataract may allow the development of treatment strategies that will prevent some cataracts[3].

Diagnosis

The diagnosis of cataract is usually simple. It is based on a reduced visual acuity, and a diminished, or absent, red reflex on ophthalmoscopy. Detailed examination of the lens requires a slit lamp and dilated pupils, but in many cases the diagnosis is easily made with a torch and ophthalmoscope. The WHO has produced a simplified classification of cataract that grades nuclear, cortical and posterior sub-capsular lens opacities separately.

Cataract does not directly affect the retina or optic nerve, so it will not cause any reduction in the direct or consensual pupil reaction to light. If a patient has poor vision, lens opacity, and a reduced pupillary response to light, it is likely that they have some other condition, such as glaucoma. This is an important distinction as both cataract and glaucoma present as gradual, painless loss of vision in elderly patients. However, vision lost due to glaucoma cannot be restored, but visual impairment caused by cataract is reversible.

Management

The only effective treatment for cataract at present is surgery. There is no good evidence that any drugs or eye drops can delay, or reverse, lens opacities. Surgery is usually successful and inexpensive, however, the majority of cataract-blind patients do not have an operation. There are a number of barriers that prevent patients attending for surgery.

Box 1 Risk factors for opacification of the lens (cataract)

Diabetes	Good control of blood sugar is associated with reduced incidence of cataract surgery
Daylight	Increased ultraviolet light exposure is associated with cortical cataract
DNA	Genetic factors may account for up to 30% of cataracts
Diet	Recent evidence indicates that anti-oxidant and vitamin supplements have no effect on the progression of cataract
Dehydration	Correlation in India between dehydration crises and cataract
Deadly habits	Cigarette smoking associated with higher risk of nuclear cataract
Drugs	Systemic steroids, equivalent to prednisolone 10 mg/day, increases the risk of posterior sub-capsular cataract

Barriers

Some of the major barriers are summarized in Box 2. While many can be overcome by providing better, or more accessible services, others can only be reduced by action in the community. Although cataract is not amenable to primary prevention in the same way as vitamin A deficiency or trachoma, a similar emphasis on community involvement is required to identify and refer patients. The most critical area for community involvement is case finding. This is best accomplished by members of the patient's own community. These field workers do not require a high level of education – their role is to inform, and raise awareness rather than to diagnose or treat. Sometimes all that is needed is reassurance about the cost of surgery, or the provision of someone to accompany the patient to the eye clinic. Estimates suggest that each year for every 10 000 people, approximately 20 need to be identified and motivated to go for cataract surgery.

Surgery

The main reason for surgery is to improve vision. If patients have reduced vision which impairs their ability to carry out normal daily activities, and they have sufficient cataract to account for the loss of vision, then surgery is indicated, provided there is no other pathology that would prevent any improvement in vision.

There is no need to wait until a cataract has reached a certain stage of maturity before offering surgery. Equally, setting a particular cut-off of visual acuity is unhelpful as the requirements for detailed vision vary from person to person, and are often related to occupation. With increasing economic development, the demand for surgery at better levels of vision will increase, and the number of operations required to meet this demand will also rise[4].

There are two different techniques for cataract surgery. Intra-capsular cataract excision (ICCE) removes the cataractous lens in one piece, within its capsule. This was the operation of choice in most developing countries until quite recently. However, it has now largely been superseded by extra-capsular cataract extraction (ECCE). In this operation the lens capsule is opened, and the nucleus is removed either manually, or by emulsifying it with ultrasound energy (phacoemulsification). The posterior part of the lens capsule is left in the eye as support for an artificial lens implant (intra-ocular lens, IOL). ECCE causes fewer blinding complications than ICCE, but opacification of the posterior capsule can be a problem. Fortunately the incidence of posterior capsule opacity following cataract surgery in developing countries appears to be relatively low.

IOL

Fifteen years ago, IOL implants cost £150, and were made only in the USA and Europe. They are now manufactured in several developing countries, including India, Eritrea and Nepal. High quality IOLs are available for less than £3 each and provide permanent correction of the severe refractive error caused by removal of the patient's own lens. Several studies have demonstrated the safety of the lenses in developing countries[5–7]. It has also been shown that, as well as being safe, insertion of an IOL provides a significantly better quality of life than the use of aphakic spectacles. We recommend that an IOL should be inserted in all routine surgery for age-related cataract, provided that the surgeon is suitably trained and adequately equipped.

Outcomes

Unfortunately, although cataract surgery is usually very safe and effective, several population-based studies have found a discouraging number of patients who suffer very poor outcomes[8–10]. In these surveys, the majority of poor outcomes are due to uncorrected aphakia (refractive error due to no lens or IOL) caused by lost or broken spectacles. As IOL implantation becomes the norm,

Box 2 Barriers

Awareness	Patient does not realize that blindness is due to potentially curable disease – assumes it is a normal part of ageing
Bad treatment	Aware that surgery may help, but reluctant as the person with cataract knows others who have had a bad visual outcome, or have encountered rude or unhelpful staff at the clinic
Cost	Willing to attend for surgery, but believes that it will be too expensive
Distance	Willing to attend and pay for surgery, but cannot travel to clinic

Box 3 Poor outcomes

Selection	Poor case selection, that is operating on patients who have other eye disease, such as glaucoma or corneal scar
Surgery	Surgical complications, such as vitreous loss or infection
Spectacles	Uncorrected refractive error following cataract surgery. Even with an intra-ocular lens (IOL), there may be significant refractive error, requiring correction with spectacles
Sequelae	Late post-operative complications, like posterior capsule opacification

uncorrected aphakia will become less common. However, even in patients who have had an IOL, a significant proportion still have a bad result. The major causes of poor outcomes are summarized in Box 3.

Until recently the emphasis in controlling cataract blindness in developing countries has been on increasing the quantity of cataract surgery; there is now an equal emphasis on improving the quality of surgery as well[11]. One way to achieve this is to monitor prospectively the results of cataract surgery and identify any causes for poor outcomes. Corrective action can be taken to improve the results, and the entire eye surgical team becomes more sensitive to issues of quality as well as quantity[12]. The WHO recommends that, with available spectacle correction, no more than 5% of eyes should have a vision of less than 6/60, and 80% should see 6/18 or better (90% with best correction).

Finance and cost-effectiveness

Blindness has huge social and economic costs as well as the obvious loss of quality-of-life for each blind person. It has been calculated that blindness costs the Indian economy four billion US dollars per year. Approximately one half of this cost is due to cataract.

Cataract surgery itself is relatively inexpensive. Most inputs are manufactured in the developing countries. The additional cost of performing one cataract operation can be reduced to £20 or less by purchasing from low cost suppliers. However, the major costs of any operation are the fixed expenses, e.g. buildings, equipment depreciation, staff salaries, and training. These can only be reduced by increasing the number of operations carried out and maximizing the use of personnel and facilities. If cataract surgery is well organized, and large numbers of operations are performed, it can be one of the most cost-effective interventions in medicine; it has been calculated that cataract surgery in a blind person costs less than £3 per quality-adjusted life year[13].

Planning services

One way of estimating the requirement for cataract surgery services is to calculate the cataract surgery rate (CSR). This is the number of operations carried out in one year per million population. If a clinic serving a population of 500 000 people performs 800 cataract operations in one year, the CSR for the population is 1600. Most developed countries, where cataract is no longer a major cause of blindness, have a CSR of over 4000, and this is the eventual Vision 2020 target for CSR. Most African countries have a CSR of less than 1000, while in India it is now over 3500[14].

In order to raise the CSR, both the demand for surgery and the supply of surgery must be increased. Increasing demand requires community-based intervention, with social marketing, case-finding, and outreach clinics to identify cataract patients. Increasing the supply of surgery requires an efficient use of resources, both human and material. In some countries this will mean training medical assistants to deliver cataract surgery, and in most of the developing world it will mean delegating more tasks to mid-level ophthalmic personnel.

Conclusion

Cataract remains the leading cause of blindness in the world. Because of the demographic change, and our inability to prevent cataract, its prevalence is increasing. However, cataract *is* curable in the majority of patients. A well-designed cataract programme, integrating community-based case-finding, with efficient and high quality surgery, has the potential to make a substantial impact on the quality of life of most communities in the developing world.

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Refractive errors

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Introduction

A refractive error is due to an anatomical condition of the eye which causes images of objects not to be focused on the retina. Refractive errors can be easily diagnosed and effectively treated with spectacles. Despite this, uncorrected refractive errors are a very important cause of poor eyesight worldwide.

It has been estimated that in many countries, uncorrected refractive errors are the second most common cause of treatable blindness after cataract[1]. In Andhra Pradesh in India, the number of blind-person-years due to refractive errors was twice that due to blindness caused by cataracts, reflecting the high number of young people affected by refractive errors. Myopia is the most common eye condition worldwide. In East Asia, the prevalence of myopia has reached epidemic proportions with, for example, a prevalence of 84% in 16–18-year-old Taiwanese school students[2]. Poor eyesight due to uncorrected refractive errors has a negative impact on academic and professional achievement, and it increases the likelihood of trauma and social isolation.

Given the frequency and the simplicity of treatment, the correction of refractive errors has been made one of the priority areas of the WHO initiative, *Vision 2020*[3].

Types and aetiology

While myopia (short-sightedness) compromises distance vision, hypermetropia (long-sightedness) impairs near vision. Astigmatism, caused by a non-spherical cornea, impairs both types of vision.

Most newborn children are hypermetropic. This hypermetropia decreases with age as the eye enlarges. The refractive status at 5 years of age is predictive for the refractive status in later life. Children at 5 years who are still slightly hypermetropic [up to 1.5 dioptres (D)] are likely to end up emmetropic (normal sighted) in later life. Those with higher degrees of hypermetropia are likely to stay hypermetropic and those who are emmetropic or myopic at this age are likely to become myopic. Myopia most often develops between the ages of 10 and 14 years, particularly around the growth spurt associated with puberty, and stabilizes by the late teens or early twenties. The younger the age at onset of myopia, the more severe will be the final refractive error[4].

Astigmatism and hypermetropia are inherited disorders. Myopia is caused by a combination of hereditary and environmental factors, even though the relative contributions of genetic and environmental factors are not fully understood. Risk factors that have been found to be associated with myopia in different cultures are age, socioeconomic status, education, Asian ethnicity and a family history of myopia[5]. Exposure to near work, such as reading has been the most consistent environmental factor that has been linked to the development of myopia, even though measuring near work accurately has been problematic[6,7].

Presbyopia is the loss of ability to see near objects clearly, due to increasing rigidity of the ageing lens which causes loss of accommodation. This process starts to occur naturally around the age of 45 years. Presbyopia starts about 5 years earlier in countries close to the equator[8].

Refractive errors can also be secondary to other eye disorders. For example myopia can be secondary to nuclear sclerosis of the lens associated with cataract, or to diabetes due to an increase of the refractive power of the lens. Removal of the natural lens without replacement by an artificial lens results in aphakia. Aphakia produces a high degree of hypermetropia, which can be corrected with spectacles of approximately +10 D power. In some African countries, uncorrected aphakia is a major cause of blindness[1,8].

Magnitude

Population-based cross-sectional surveys of refractive errors in children aged 5 to 15 years showed that more than 9% of rural Chinese, 2% of rural Nepalese, and 7% of urban Chilean children would benefit from spectacles[9–11]. In school-age children in rural India, the prevalence of myopia (< -0.5 D) was 4.1% versus 7.4% in urban India and of hypermetropia ($\geq +2.0$ D) 0.8% in rural versus 7.7% in urban India[12,13]. The higher prevalence of refractive errors in urban settings has also been shown in other studies. In Taiwan, the prevalence of myopia in 15-year-old children was 71% in urban and 59% in rural areas[14]. Children of Tibetan origin living in urban Nepal had a prevalence of myopia of 22% compared with 3% of those living in a rural area with less intensive schooling[15]. In a school survey in Oman, the prevalence of myopia in rural, remote areas was 2.0% compared with the national average of 5.2%[16].

Even in countries with a fairly low prevalence of refractive errors, there may be subgroups of the population in whom refractive errors are more common. In general, the prevalence of refractive errors in African populations is low, often less than 2–3%[17,18]. However, a recent study in Tanzania found that 6.1% of secondary school children had refractive errors causing poor eyesight ($<6/12$ in at least one eye)[5]. Eighty per cent of the students with refractive errors did not have spectacles even though nearly all of them had good eyesight after correction.

Even in countries with well-resourced health systems, uncorrected refractive errors can be a major cause of