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Cataract services: increasing utilisation and creating demand

EDITORIAL

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Introduction

The idea for this theme was germinated by a member of the editorial committee who pointed out that "We know quite a lot about how to deliver cataract services, but not as much about how to deliver the patients". In this issue, Tan cites a dramatic illustration from China showing the imbalance between the provision and use of cataract services; a fully equipped department, with advanced technology and 24 ophthalmologists, performed less than 100 cataract operations in a year.

Of course, this concern is not new. Six years ago the *CEHJ* included an article on reducing barriers to cataract surgery.[1] More recently, Muhit[2] directed the spotlight on barriers to treatment for childhood cataract. Much of what was covered in issue 58 (2006), *Outreach: linking people with eye care*, is also relevant here. Furthermore, the eye health literature continues to include reports from different parts of the world based on studies to assess the barriers to uptake of cataract services.

The balance between supply and demand

Promoting the use of cataract services requires a balance between supply and demand (Figure 1, overleaf). In this issue, we focus on the use, rather than the supply of services. Standing[3] identifies two components of 'demand side' concerns: "One is understanding health seeking behaviours and patterns of utilisation with a view to either changing them or catering better to them. The other is to find ways of harnessing the demand side in pressing for change and improving the responsiveness of the supply side". While the first component is well recognised, the eye health community has paid less attention to the second component, which encompasses ideas expressed in the 2004 World Development Report[4] on improving service delivery to poor people. The notion of accountability is linked to the notion of empowerment and capturing consumers' voices. Successfully achieving this means building the confidence, trust and motivation for patients to deliver **themselves** to services, and for communities to play a role in shaping those services to meet their needs.

The joy of sight regained. TANZANIA

Suzanne Porter/Sightsavers

There are three main questions related to use of health services. **Are they accessible?** The answer lies in geographical location, transportation availability, and organisational factors such as timing of services. **Are they affordable?** We need to look at the direct costs of fees, the indirect costs of transport, food and lost earnings, and the impacts of these costs on household livelihoods. Finally, **are the services acceptable to patients and their families?** Trust in

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Supporting VISION 2020: The Right to Sight

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the quality of clinical care, the cultural acceptability of how services are delivered, interpersonal communication and the dignity afforded to patients, are relevant here. The challenges particular to cataract services are addressed in the articles in this issue.

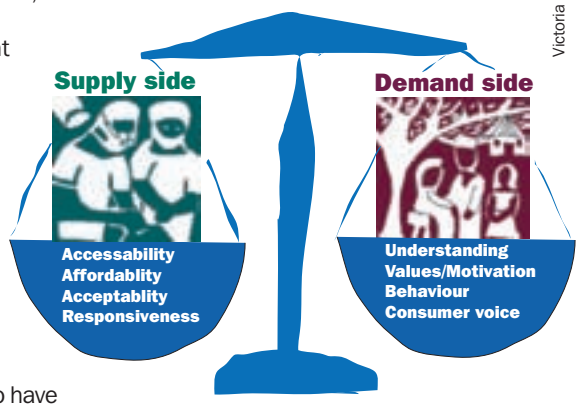
Making cataract services accessible

Lewallen and Courtright consider the special problems faced by women. Gender-based disadvantage means that women not only are disproportionately affected by cataract, but they also have less access to information, greater barriers to travelling to services, and also greater resignation to the fate of blindness, as confinement to domestic roles makes women's disability less apparent than the loss of mobility experienced by men. The article describes a 'bridging strategy' to bring female patients closer to providers both geographically (through outreach and transportation) and culturally (through appropriate counselling and involvement with social networks).

Making cataract services affordable

It is important to place affordability of cataract services within the wider issue of affordability of health care. There is a substantial body of evidence on the catastrophic impact of illness arising from lost income and from the out-of-pocket expenses of accessing health care. Xu *et al.*[5] define spending on health as being catastrophic if a household's financial contributions to the health system exceed 40 per cent of the income remaining after subsistence needs have been met. If households suffer impoverishing financial shocks as a result of serious and acute health conditions, it is not surprising that an event considered part of natural ageing, and without life-threatening consequences, receives low priority in household spending. Cataract treatment should be affordable to households and based on ability to pay. A number of programmes have grappled with the issue of affordability and have devised creative strategies and formulae (see useful resources on page 72). The case study from China in this issue demonstrates the "serious imbalance between hospital charges for cataract surgery and patients ability to pay". Village-level investigations revealed that people would be willing to pay for a cataract operation if it cost at the most 25 per cent of their annual income; in China a cataract operation can cost as much as one year's income. By bringing services closer to people, establishing communication and referral networks, and introducing a multi-tier pricing system for people of different income levels, it was possible to increase the volume of cataract operations as well as the hospitals net income.

Figure 1. Maintaining a balance between supply and demand



Victoria Francis

Making cataract services acceptable

Acceptability relates to how comfortable patients feel about using the services, and raises the issue of cultural distance between providers and beneficiaries. It is widely accepted that persuading people to take up services is often best done by those close to the community. Such individuals have been given a range of titles such as aphaikic motivators, cataract case finders, etc. The case study from Nigeria describes expanding the role of Community Based Distributors of Ivermectin. The Mexican case study shows how demand for eye care was stimulated by community workers who integrated eye care with their other roles, and were able to provide a service which people value, i.e., presbyopic spectacles. The case study from Cambodia describes how outreach services can help to reduce the gap between people and medical services, but also cautions that this depends on good counselling, and might still not be enough for people to make the step from being identified as needing cataract services, to actually going for the operation.

For many patients, the strangeness of hospitals and experiences of less than courteous or sensitive treatment by medical personnel, may make them reluctant to subject themselves to the ordeal of cataract surgery. This raises supply-side issues. How culturally acceptable is the hospital environment? Are the needs of women addressed, for example, through separate seating areas, separate wards for women, availability of female counsellors, and private washing and toilet facilities? Is everything being done to ensure the dignity of patients?

Trust is closely related to acceptability. Trust in services accumulates through experience, reputation accrued through a history of good surgical outcomes, and the testimony of satisfied patients. However, as noted in some of these articles, trust can also be undermined by a perception that the services offered by outside agencies is better. Tan refers to the "tidal wave of problems" that can follow when well-intentioned one-off programmes offer free services. Cains and Sophal describe how a prevailing attitude of mistrust of locally trained surgeons is

compounded when a foreign surgical team arrives, provides free surgery and undermines the trust being gradually built up by the local eye doctors. Ogoshi also refers to the problems that arise from free eye camps threatening the sustainability of permanent eye hospital services.

Increasing the motivation to take up cataract services

Addressing the barriers to uptake of surgery is crucial, but still may not be enough. People need to be motivated to act. Motives or reasons for changing behaviour or spending money and energy on acquiring something, are described in marketing terms as 'consumer drives'. This concept captures the notion of internal tension between the desired ideal state (sightedness for oneself or a family member) and the actual state (diminishing or lost sight). This arouses motivation, propelling the individual and 'close ones' to seek solutions. The information that cataract is curable might not arouse sufficient drive to take up the services. However, the value placed on sight throughout the life span might provide the motivation to act. Every context is different, and this is why qualitative methods are becoming more widely valued as a way to understand the mindset and motivations of users.

Increasing accountability

The value of involving satisfied patients is well recognised. Perhaps there is also a role to be played by the less satisfied patients. This is potentially sensitive, but in-depth understanding of their experiences, and reasons for dissatisfaction, might provide insights to help providers make services more responsive to patients. It is interesting to note in the article by Kuper *et al.* that the Rapid Assessement of Avoidable Blindness (RAAB) methodology includes a question to those who have undergone cataract surgery, to find out details of their operation, including satisfaction.

Conclusion

Much has been written about increasing uptake of cataract services. In this issue of the *CEHJ*, we present recent experiences and case studies on increasing the use and demand for cataract services amongst specific groups (women) and populations in China, Mexico, Nigeria and Cambodia.

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GENDER DIFFERENCES IN CATARACT

Increasing uptake of eye services by women

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Is there a problem for women?

It often surprises people, but it's no secret to eye health workers in poor countries, that patients who live with blindness and low vision in these countries often do not make use of existing services. Many programmes, particularly in Africa, struggle to get patients in for surgery. How many eye health workers also know that the problems of access and acceptance are generally worse for women than for men and that women comprise a disproportionate number of the world's blind?

Figure 1 shows the proportion of blind who are female in Asia and Africa.[1] Why does this imbalance occur?

It is well established that the major cause of blindness in poor countries is cataract. Figure 2 is derived from population-based surveys in several countries and shows that 60 to 65 per cent of those blind from cataract are female. This is partly because women live longer than men and thus are more likely to develop cataract. In addition, women have been shown to have a slightly increased age-adjusted risk of cataract.[2] Cataract blindness, however, can be cured, or even prevented if the operation is done early enough, and herein lies the crucial imbalance: women do not receive cataract surgery at the same rate as men. Figure 3 shows the cataract surgical coverage (which measures the proportion of the need for cataract surgery in the community that is being met) reported in a number of studies. These coverage figures are higher for men.[3-5]

This inequity is often overlooked because

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Figure 1. Gender differences in the burden of blindness in the population

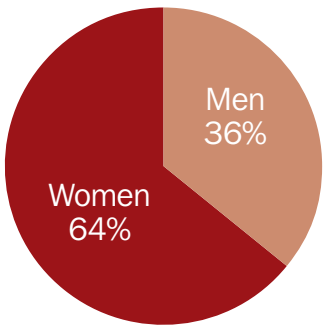


Figure 2. Estimated percentage of people with cataract who are female

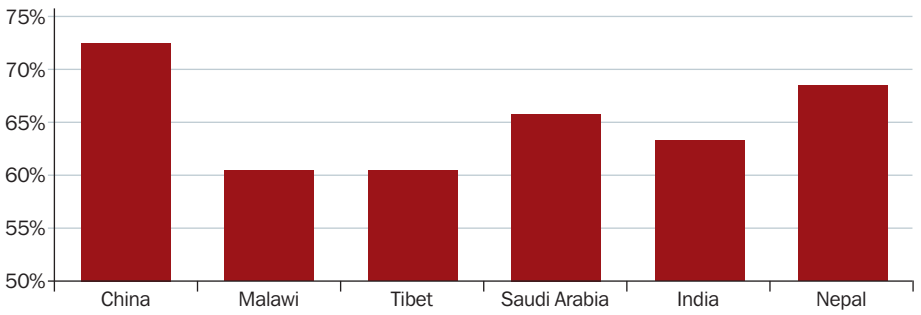
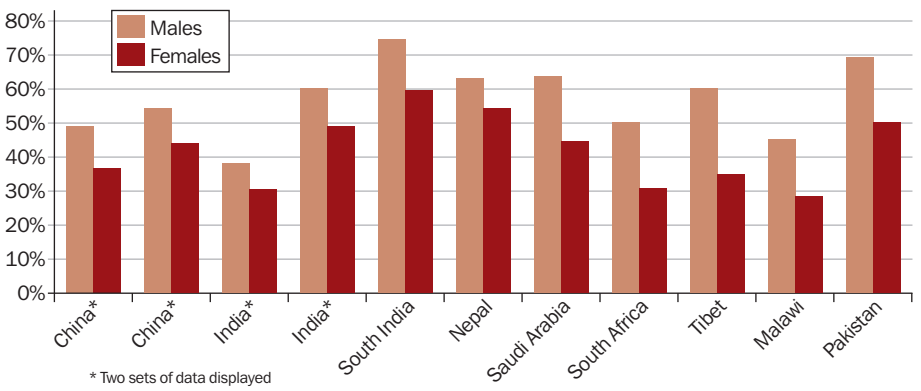


Figure 3. Data on cataract surgical coverage from various studies



most programmes report about the same number of cataract operations performed in women as in men. The chances are, if you look at the records of your hospital, you will find a 50/50 split by gender in the number of cataract operations. However, since women have more cataract to begin with, we should perform about 60-65 per cent of our cataract surgery in women, if we are to achieve equality in cataract surgical coverage for men and women. We find similar inequity in glaucoma. Chronic open-angle glaucoma (COAG) is the second leading cause of blindness in sub-Saharan Africa. It occurs equally often in males and females, yet males comprise around 70 per cent of new COAG patients at the two largest referral eye clinics in Tanzania[6] (also authors' own data).

Hospitals and clinics are not deliberately discriminating against women, but women face special problems in accessing services. We need to consider these in order to plan solutions.

What special problems do women face?

The *Community Eye Health Journal* has published articles discussing barriers that prevent patients from accessing services. We like to think of barriers occurring at three levels: lack of awareness of services, lack of access to services, and reluctance to accept services. All three of these types of barriers tend to affect women more than men. Consider the following:

Awareness

Women are less likely to be educated than men. They are therefore less likely to be aware that some blindness can be cured, to know where to go, and to know how to get there. Elderly women, with little or no formal education or exposure to hospital settings, may have more concerns and questions than men regarding surgery. Language barriers or unfamiliarity with the health system can lead to decreased awareness of health care services by some women.

Access

Travelling away from home for surgery is hard for all old people, but it is often more difficult for women. In many cultures, women have little money or control over how money is spent. Many elderly people depend mostly on their children to cover the costs of cataract surgery. We found in Tanzania that young heads of households are less likely to encourage and support old women to go for surgery than old men. In many cultures women cannot travel unless accompanied by a male, and the lack of someone to accompany them can also be a barrier.

Acceptance

Quality of life expectations in old age are gender-specific in some cultures and the perceived 'benefit' of cataract surgery may be gender-dependent. For instance, elderly men expect and are expected to participate in community meetings; their involvement requires mobility. Women, on the other hand, may be more confined to the house.

In summary, men and women all face the same barriers, but many of these are more difficult for women to overcome.

How do we help women have access to services?

Our experience in developing and studying VISION 2020 programmes in eastern Africa indicates that several essential components must be in place if a 'community' is to have access to an eye care service. These are shown in Figure 4. We have found two specific components to be especially important to ensure care for women: transportation and counselling. Both can be built into whatever strategy the programme uses to establish a 'bridge' between the hospital services and the community.

Transportation

Hospitals are still widely scattered in resource-poor countries and patients often cite distance as a barrier. Either the surgical team has to go to the patients or the patients must come to the surgical team. We have found that females are significantly more likely than males to access services through programmes that provide transport from rural areas; they are less likely to come to the hospital on their own.

Counselling

This task is often assumed to be done by nurses. Sometimes it is, but more often it is neglected or given little attention in a busy clinic or screening session, where a nurse has other duties to perform. It is preferable to have one person solely dedicated to the counselling task during the clinic or screening session; this ensures that patients and their families really have a chance to have their questions answered. Accepting surgery is a family decision and engaging the family through good quality counselling is essential. The counsellor needs to be very familiar with all aspects of the process. What will happen in the hospital? Will the patient be alone? Is surgery painful? How long is the hospital stay? How will the patient get back home? How much will it cost for surgery and 'extras'? What if the patient wants to wait until next month? Patients need answers to these questions before they can agree to surgery.

In addition, there are other ways in which programmes can target women. Special educational programmes with women's groups help to raise awareness among women about eye health. When women meet other women who have had successful surgery, they are more likely to accept surgery themselves. And let us not forget that men – husbands, brothers, and sons of visually impaired women – are always part of the decision-making process. They need to know that women have the same 'right to sight' as men do.

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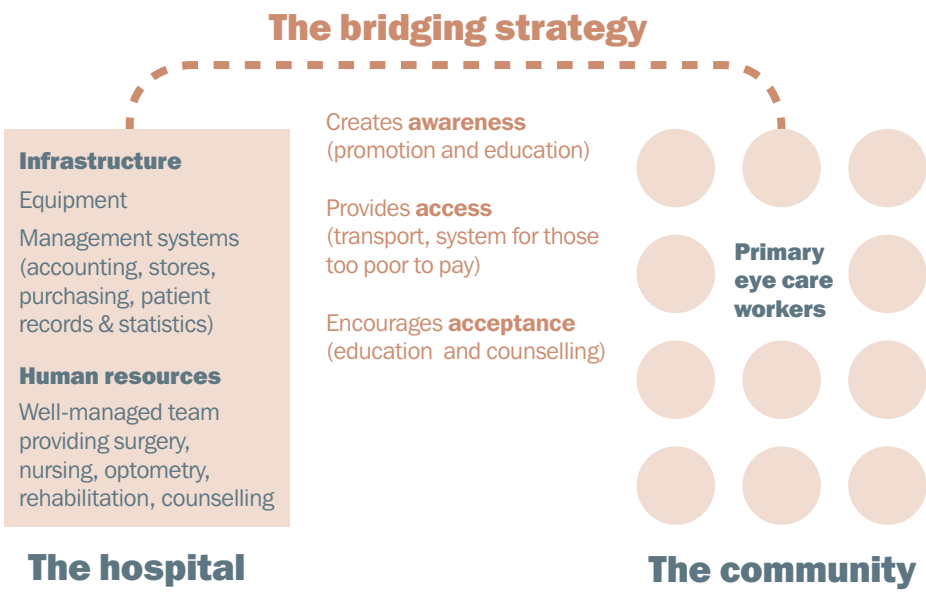
Figure 4. The bridging strategy



Increasing the volume of cataract surgery: an experience in rural China

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Xie Weilin/ORBIS

A follow-up examination for a cataract patient by a doctor from Wuzhishan Eye Hospital. CHINA

Cataract: the situation in China

Eighteen per cent of the world's blind people live in China. The country is home to one of the world's largest populations of blind people, an estimated 6.6 million. Cataract is the number one cause of blindness in China, accounting for nearly 50 per cent of all cases. China is also estimated to have the world's most rapidly ageing population. By 2020, the country's elderly population is expected to increase by 90 per cent and reach 240 million people. In 2005, about 600,000 cataract operations were performed in China, compared to 1.5 million LASIK operations. The cataract surgical rate (CSR) in China is around 450-460, compared to 3,700 in India.

What is wrong with China's cataract services?

From the facts listed above, it is easy to see the gravity of China's cataract situation today. The country's rapidly ageing population compounds the problem. While China's economy has been developing fast, its basic social services have lagged behind, particularly health care services in rural areas. Ninety percent of the rural population (about 700 million) is marginalised in the country's health care system. The reform of China's health system since the 1980s has not resulted in sufficient government investment. Government expenditure on health made up only 17 per cent of the country's total health expenditures in 2004, compared to 40 per cent in 1980.[1] The government is gradually reducing its subsidy to public hospitals; these hospitals are now becoming increasingly profit-oriented and target primarily the rich.

The low CSR in China is mainly caused by a serious imbalance between hospital charges for cataract surgery and patients' ability to pay.[2] In rural western China, the average annual net income per capita is about US $224 (RMB 1,854.9),[3] while charges for cataract surgery at the county hospital level vary from US $200 to US $300. These prices rise to US $380-500 at provincial hospitals and vary between US $630 and US $1,000 in larger cities such as Beijing and Shanghai. It is generally accepted that a simple cataract operation in China can cost patients as much as one year's income. When indirect costs such as travel and accommodation are taken into account, it becomes virtually impossible for rural patients to get cataract surgery in a large city. That is why it is not uncommon in China to see a well-equipped hospital with competent cataract surgeons, but very few patients. In a provincial level hospital that ORBIS staff visited last year, the department of ophthalmology was fully equipped with advanced technology and had 24 ophthalmologists, but less than 100 cataract operations were performed a year. The minimum price for a cataract operation at this hospital was US $400 (i.e. twice the average annual income).

The situation of cataract services in rural areas is even worse than in provincial hospitals. There is a vicious circle in county hospitals: hospitals try to charge patients as much as the government Bureau of Price Management allows; the high price makes cataract surgery less attractive to patients; fewer patients means fewer opportunities for doctors to practise their surgical skills and improve quality of care; low quality makes doctors less trusted by patients, therefore fewer patients come to the hospital; this in turn means that the hospital desperately needs to make up its deficit by imposing higher price for cataract surgery.

A number of health authorities and organisations concerned with the prevention of blindness offer free cataract operations to cope with China's growing cataract problem. This is done via initiatives such as 'Health Express', various surgical buses, and other one-off programmes. While highly commendable, such initiatives can create a tidal wave of problems for local eye care providers, who are left with no patients when free operations cease to be available. New patients are determined to wait for the next external intervention and are very reluctant to undergo any form of paid surgery. This places severe limitations on the future development prospects and the long-term survival chances of hospitals in these areas, as no government, organisation, or individual can afford to provide free cataract services on a permanent basis.

Lessons from the ORBIS field practice

ORBIS International has been fighting avoidable blindness in China since 1982. As ORBIS progressively shifts its focus to China's rural areas, where there is a pressing need for improvement in blindness prevention programmes, our projects focus increasingly on training local ophthalmologists and nurses to serve these underserved populations.

In 2000, ORBIS launched a Blindness Prevention Model County Project in Wutai County, Shanxi Province. Ophthalmic equipment was donated to Wutai County Hospital, staff were trained in cataract surgery, and funding was provided to screen for cataract among one-fourth of the county's 360,000 residents. Despite our efforts, the number of cataract operations did not rise substantially. We learned two important lessons from this project. Firstly, we learned that ophthalmic infrastructure, technology, training, and surgical skills, as well as funding for screenings alone, are not

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enough to increase the volume of cataract surgery. Secondly, we learned that affordability is the crucial obstacle that prevents us from finding a long-lasting and effective solution to increase the cataract surgical rate.

As a result, we began to ask questions about how to:

- lower the cost of eye care services so that it is appropriate to the income level in rural areas in China
- maximise benefits to patients while ensuring the sustainability of the local eye care market
- reverse the vicious circle of rural cataract services.

With answers to these questions, ORBIS China implemented a plan to raise public awareness of the importance of eye health and to ensure that quality eye care was readily available, sustainable, and affordable for all.

In March 2004, we initiated a rural project in Xiangyun County, Yunnan Province, to build a modern eye disease prevention centre within the Xiangyun County Hospital, a government hospital. Ten months later, we launched another rural project in Wuzhishan County, in the central highlands of Hainan Province. The project partner, Wuzhishan Eye Hospital, is privately owned but registered as a non-profit NGO hospital. We chose these two dissimilar hospitals in order to explore different ways of increasing the volume of cataract surgery in China.

Figure 1. Geographic location of Xiangyun and Wuzhishan

Xiangyun County has a population of 430,000. There are about 2 million villagers in five surrounding counties where cataract surgery is not available. Before the implementation of the project, Xiangyun County Hospital was the only place to offer extracapsular cataract extraction with intraocular lens implantation (ECCE/IOL). About 200 such operations were performed in the county hospital every year. The price varied between US $180 and US $300.

Before 2004, there were no eye care services available in Wuzhishan County (population 1 million including surrounding counties). To receive cataract surgery, patients had to go to the provincial capital Haikou (one day travel), where the price of the operation varied from US $300 to US $400.

In both areas, farming is the main productive activity. In 2003, the average annual net income per capita was US $240 in Xiangyun and US $217 in Wuzhishan. Given this economic reality, we need to address how eye care services can be made affordable.

We began by building the capacity of both partners (equipment, training, referral network, public awareness), then we introduced a multi-tier pricing system to accommodate people of different income levels. Investigations at the village level revealed that, if the price of the operation was at the most 25 per cent of a person's annual income, people would be willing to pay for the service. Another survey indicated that the price villagers were willing to pay for cataract surgery was equivalent to the price they would get for selling a grown pig at the local market. We also worked out in detail

Gu Zongzu/ORBIS

Cataract screening in a village. CHINA

the direct cost of surgery to the hospital. It was encouraging to find out that this direct cost to the hospital (US $28) always turned out to be lower than what most villagers considered an affordable price: US $60-75 in Xiangyun and US $50-60 in Wuzhishan. Direct costs were calculated using inexpensive, locally produced and sourced IOLs, rather than the more expensive supplies promoted by large companies. The margin between direct costs and affordable price indicates where a standard price for a cataract operation can be fixed and it generates net income for the hospital to sustain its services and develop further.

Result in Wuzhishan

In 2005, at Wuzhishan Eye Hospital, the cost of a cataract operation was in total US $84.5, of which US $56.5 was the hospital's fixed indirect cost, which included hospital management costs, salaries, depreciation of equipment, utilities, etc. The direct cost was US $28, which included:

- US $16 for IOL (locally produced), suture, and viscoelastics
- US $6 for medicines
- US $6 for pre- and post-operative examinations.

At the end of 2005, we can see from the table below that the hospital had a net loss

Table 1. Wuzhishan Eye Hospital cash flow in 2005 (in US $)

	Volume of Cataract Surgery	Gross Income	Actual cost (US $84.5 per operation)	Balance
26 cases (5 per cent) free	26	0	2,197	-2,197
112 cases (21 per cent) at US $24	112	2,688	9,464	-6,763
128 cases (24 per cent) at US $36	128	4,608	10,816	-6,184
152 cases (29 per cent) at US $60	152	9,120	12,844	-3,671
91 cases (17 per cent) at US $96	91	8,736	7,690	1,099
18 cases (3 per cent) at US $120	18	2,160	1,521	652
5 cases (0.9 per cent) at US $180	5	900	423	483
Totals	**532**	**28,212**	**44,955**	**-16,581**
Income from other treatments		12,198	12,343	-145
Total in year 2005		**40,410**	**57,298**	**-16,726**

Table 2. Projection of surgical volume and net income for the next two years (in US $)

Year	Cataract surgery	Other treatments	Gross income	Expenses	Balance
2004 (actual figures)	102	87	10,958	11,614	-656
2005 (actual figures)	532	569	40,410	57,297	-16,727
2006 (projection)	798	1,500	84,058	79,686	4,372
2007 (projection)	1,064	2,000	109,420	96,586	12,835

of US $16,727. However, compared to 2004, the number of cataract operations was multiplied by 5.2. Affordable prices, public education, and the estimated 3,000 new cases per year (0.03 per cent of the population) will increase uptake and reduce the unit cost per operation.

One thing merits attention. The Chinese government has acknowledged the unequal access to basic health care services between rural and urban populations, and it introduced in 2003 a new type of Rural Cooperative Medical Scheme (Xinxing Nongcun Hezuo Yiliao, or 'Xinnonghe'). A participant of the cooperative is eligible for reimbursement of 30-40 per cent of the cost of his/her cataract operation. The implementation of the cooperative scheme in Wuzhishan has enabled Wuzhishan Eye Hospital to lower its normal price for cataract surgery by a further 50 per cent. Therefore, the potential to increase the volume of cataract surgery in the future is growing.

Result in Xiangyun

Along with training for village community health workers, public education among villagers, and a functionally strengthened referral network between county, township, and village, the multi-tier pricing system has increased the hospital's volume of cataract operations, as well as its net income (see Table 3).

The new type of Rural Cooperative Medical Scheme has not yet been implemented in Xiangyun. However, with the support of local government, poor patients are able to get financial assistance to reduce their portion of payment for cataract surgery at the hospital.

Nowadays, in Xiangyun, patients are satisfied because they pay only one-third of the previous price to get cataract surgery done. The hospital management is pleased because net income has been continuously increasing, by 44 per cent in 2004 and by 43 per cent in 2005. The doctor is happy because he is enjoying a good reputation, as his surgical skills and the quality of eye care delivery are continuously improving.

These two projects of ORBIS China, in Xiangyuan and in Wuzhishan, have shown that it is not necessary to go looking for patients when the supply and demand sides of the market are in place, and when one adopts a 'small profit and quick turnover' approach to the pricing of surgery. The providers can increase surgical volume by lowering prices and still generate a substantial income.

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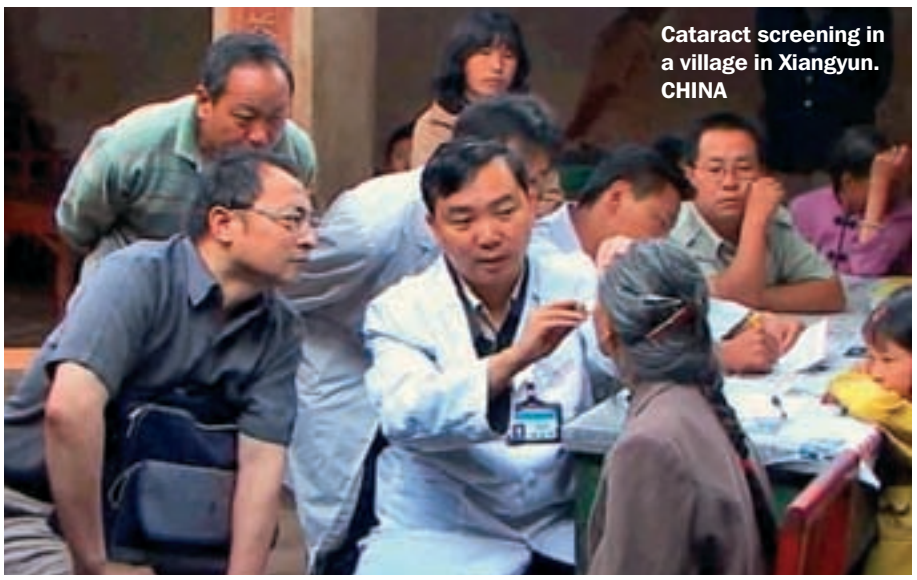

Cataract screening in a village in Xiangyun. CHINA

Gu Zongzu/ORBIS

Table 3. Surgical volume and net income of Xiangyun County Hospital (in US $)

	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006 (first 3 months)
Number of cataract operations performed	**192**	**206**	**430**	**482**	**180**
free surgery	0	0	14	28	5
at US $62.5	0	0	86	95	18
at US $100	0	0	170	186	72
at US $125	0	0	89	89	23
at US $187.5	122	126	32	36	26
at US $250 and above	70	80	39	48	38
Gross income	US $38,356	US $41,444	US $37,525	US $49,554	US $24,296
Actual cost	US $30,685	US $32,326	US $24,391	US $30,724	US $13,363
Balance	**US $7,671**	**US $9,118**	**US $13,134**	**US $18,830**	**US $10,933**

Popularising eye health services in southern Mexico: community workers meet a felt need


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Introduction

Programmes for blindness prevention in southern Mexico face multiple challenges. The people in greatest need live in remote rural villages. Mountain ranges and bad roads make access to these villages difficult. Multiple languages (16 distinct languages in the state of Oaxaca alone) along with a diversity of customs and beliefs, make effective communication challenging. It is impossible for an ophthalmologist acting alone to gain the access needed to serve these communities well.

Figure 1. Location of Mexico

Community eye health promoters

The government, churches, and NGOs are already involved in a wide variety of programmes to meet social needs in these communities. Workers who either live in the community or travel there on a regular basis are involved in initiatives such as nutrition programmes, basic health care, sanitation, and social work. They understand the local languages. They know regional customs and how to work with local authorities. These workers, equipped with the necessary knowledge and skills, are ideally positioned to deliver eye health services. Furthermore, government agencies, NGOs, and churches are pleased to have their workers acquire new skills and bring eye health services to the villages.

Most often this is done on a part-time basis as workers 'piggy-back' eye services onto their other routines. In this way there is little or no additional expense. The newly trained workers are known as community eye health promoters (CEH promoters).

Training

To be enthusiastic partners in blindness prevention, and not merely functionaries, community eye health workers must understand what they are doing and why they are doing it.

Visual acuity testing. MEXICO

Fr Pablo Merne

Since many workers have little or no experience in health care, and no formal education beyond primary school, we developed a workshop using language and concepts tailored to their level of experience and schooling. For instance, the terms 'white part' and 'transparent part' are used instead of conjunctiva and cornea. The visual pathway is reduced to six simple steps: light (forming an image) passes through the cornea, pupil, and lens and is captured by the retina; this image is transmitted by the optic nerve to the brain where vision occurs. Students achieve a rudimentary understanding of the anatomy and physiology of the visual system.

CEH promoters learn to measure visual acuity using E charts in a programmed, standard routine. Standard-sized E characters to measure visual acuity are produced inexpensively in large quantities and mounted on stiff cardboard. Each promoter is equipped with E cards and a six-meter-long cord; these items form a portable vision-testing kit which can be used easily with all ages and levels of literacy.

The assessment is simple: vision must be 20/60 or better (20/40 for children). Lids must be clean, and able to open and close. The white part must be white. The transparent part must be transparent. The black part must be black.

Once they have acquired a basic knowledge of structure and function, as well as hands-on experience with visual acuity measurement, CEH promoters quickly understand the possible causes of decreased vision. Slides and a model eye make the concepts more graphic. Promoters master the subject of cataract and can diagnose advanced cataract using two criteria: vision is equal to or lower than 20/200 and the pupil is white. They comprehend the risks of diabetes and glaucoma. Refractive errors make sense.

The detection of problems is only the first step. The training also includes what to tell the patient. Using a list of questions frequently asked by patients and family, students participate in interactive classroom role-playing dramas in order to deepen their own understanding of problems and to prepare them to assist patients. CEH promoters are prepared to give a simple, clear explanation to patients about what their findings imply, answer questions, dispel myths and motivate patients to seek help when needed.

Supplying spectacles for reading. MEXICO

Fr Pablo Merne

Spectacles for presbyopia: meeting a need

Surveys reveal that 'tired vision', or uncorrected presbyopia, is a major preoccupation in rural communities. CEH promoters quickly learn criteria for diagnosing presbyopia. They practise determining the appropriate correction for patients by using a kit which contains lenses from +1.50 to +3.00 in half-dioptre steps, along with a needle and thread for illiterate patients and printed material for those who can read.

The provision of spectacles for presbyopia brings patients, both women and men, willingly to the promoters, and gives their work credibility and authority. Patients, promoters, and participating organisations are extremely enthusiastic

about this programme.

The programme is self-sustaining. The bulk purchase of spectacles for presbyopia from a regional marketplace reduces costs. Spectacles can then be provided to patients at cost or cost-plus. Some programmes reward CEH promoters with a small stipend from the sales.

Three days in the mountains: an example

There is no central database recording blindness prevention efforts in the villages of Southern Mexico, but a look at the experience of one team in Oaxaca indicates the effectiveness of CEH promoters. A team of six people worked in a group of villages for three days. None of them were health workers but all had participated in a three-day community eye health training. Two days were needed to travel to the villages. As a result of the three days spent by the CEH promoters in the mountains:

- 384 people over the age of 35 years received an eye examination
- 170 pairs of spectacles for presbyopia were distributed
- 43 people were referred to the ophthalmologist. The vision of those referred was:

20/100	30 eyes
20/200	24 eyes
20/400	18 eyes

The diagnoses of the people referred was cataract (17 eyes), pterygium, referred when the pterygium is at the border of the pupil (6 eyes), refractive error and/or other disease (20 patients).

Clearly, the promoters were able to address significant unmet needs.

Conclusion

The challenge to reach those most in need of eye services in regions that are geographically remote and culturally diverse, can be met by persons who already live or work in these communities. With brief but appropriate training, they become enthusiastic partners in blindness prevention. Most CEH promoters 'piggy-back' this work onto their other routines so that eye care is integrated with other health and development issues. Providing spectacles for near vision, something that people need, and which enhances their lives, helps to build trust and confidence in other eye care services and greatly increases the effectiveness of blindness prevention programmes.

Joseph Michon

Supplying spectacles for sewing. MEXICO

CASE STUDY CAMBODIA

Creating demand for cataract services: a Cambodian case study

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Background

Following decades of civil disturbance in Cambodia, by the early 1990s there were few doctors remaining in the country, and little in the way of eye care services.

With NGO support, training centres were established to train medical graduates and nurses as 'basic eye doctors' and 'basic eye nurses'. These workers were then placed in provincial eye units to serve the eye care needs of those provinces. However, it soon became clear that, despite evidence that blindness, including cataract blindness, was prevalent, patients were not attending these provincial eye units. Attention was therefore given to finding out more about the barriers preventing patients benefiting from these services.

Key barriers to access to cataract surgical services

Poverty

This is an underlying factor, one survey having rated over 90 per cent of the referred patients as 'poor' or 'very poor'. Even when the actual operation is free, the associated costs of transport and food, when patients are away from home, are often too much for patients to afford. Many will simply not consider seeking services, assuming such services will be beyond their means. Poverty interconnects with other barriers, such as the lack of someone to accompany and care for the patient while in hospital. A caretaker would need to take time away from their work; for many poor people, this could have a significant impact on the family income and contribute further to household impoverishment. In rural economies, potential caretakers can often not afford to spend a day away, particularly during harvesting season.

Attitudes towards expenditure on the elderly

Linked to poverty, are the attitudes to spending scarce resources on the elderly. We found that children, and the patients themselves, do not perceive the need or value in spending resources on medical care of the elderly patients.

Fear

This includes the direct fear of having a poor outcome from the operation, and a less rational fear of the whole concept of surgery and hospitals.

Lack of knowledge

Lack of knowledge has to some extent been addressed through efforts to educate the population about the availability and quality of eye care services. However, lack of a clear understanding of the nature of cataract, and of the possibility of treating it, is often still found to be a barrier to uptake of surgical services.

Sith Sam Ath

Patients waiting at the provincial eye unit of Kampong Thom, while nurse Mr Ty Seiha tests vision. CAMBODIA

Lack of trust in local medical personnel

In some communities there is a prevailing attitude of mistrust of locally trained surgeons, combined with the feeling that foreign doctors are better. This is compounded when a foreign surgical team arrives (often unannounced) and does free surgery, undermining the good work and trust being built up by the local eye doctor.

Some approaches to overcoming the barriers

The National Programme for Eye Health (NPEH), eye units working with NPEH initiatives or with NGO support, and individual eye doctors in Cambodia, have attempted a range of approaches to overcome these barriers. These are briefly described below.

Outreach screening activities for cataract or other causes of blindness extend the reach of provincial or district eye unit to the surrounding community. The doctor, supported by the unit eye nurses, or the nurses themselves, usually provide the outreach screening. This is a key method for promoting the uptake of cataract surgery. It provides an opportunity for community education in eye disease and the options for eye care, as well as the actual screening process. However, our experience tells us that providing an outreach screening service does not entirely overcome the barriers to uptake.

We find that of those referred to the eye unit at outreach screenings, only around

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Sith Sam Ath

Ms Yang Samphors, a village health volunteer, examines a woman during outreach screening in Kampong Chhnang Province. CAMBODIA

Sith Sam Ath

Patients are registered during the outreach screening at Vien Health Centre. CAMBODIA

40 to 50 per cent actually attend for surgery. The reasons for this appear to be similar to the key barriers described above. While outreach screening can result in a disappointing proportion of referred patients attending for surgery, it provides the opportunity to address some of the problems at their source. These activities help to create understanding about the nature of curable blindness, address concerns about cost and the need for caretakers to accompany patients to hospital, and dispel fear of the operation. The outreach screening is a good forum for addressing people's concerns, although it is important to ensure that there are enough resources available to give this the time it needs during a busy outreach session.

Financial subsidy for surgery (and often for other associated costs such as transport and food) is necessary to obtain a good 'yield' of referred patients. In many people's minds, there is a link between eye camps run in in collaboration with an NGO and the opportunity for free surgery. Free surgery might also be provided in the context of World Sight Day or other advertised periods.

Hospitals often have a degree of flexibility in fees charged as part of a cost recovery system, and they often work in co-operation with the eye unit staff or community rehabilitation bodies in administering this.

Training village health volunteers in primary eye care and screening for cataract facilitates the screening process. In one case, the Chief of Training of the hospital has taken on the role of teaching the village volunteers and conducting outreach screening with them. In another case, the eye unit returns a subsidy of one dollar to the village volunteers for each cataract patient referred. **Involvement of satisfied patients** has also been tried. One doctor makes it a practice to have a person in the screening area who has had successful cataract surgery; the satisfied patient can then explain the process and encourage others to have the operation.

Reducing the fear of the cataract operation As mentioned earlier, one approach to reducing fear is to allow enough time and resources during outreach activities for discussion with people. In any communications about cataract, the words used can make a difference. For example, one unit has found that words such as 'surgery' and 'hospital' create fear, while words like 'remove the cataract' create more confidence.

One well-established way to reduce patients' fear of surgery is the use of 'ambassadors'. These are people who have had successful cataract surgery. They are urged to talk to people who are blind when they return home and to encourage others to receive the same benefits as they have.

One doctor takes this one step further by telling patients, after a successful first eye, that he will only do the second eye if the patient brings another cataract patient along with him!

Establishing a personal relationship of trust is the key to reducing fear of surgery in the patients. All this knowledge and information will be of little value if the patient does not understand or trust the medical staff.

Overcoming the barrier of the lack of a caretaker to accompany the patient to hospital requires consideration. Two creative ways to help with this have been:

- arranging for several people to come to the surgical unit together, sharing a relative or a village neighbour as a caretaker
- when a person is in hospital without someone to care for them, the hospital social services or the NGO can arrange for someone to be the caretaker.

The NPEH contributes directly to **improving community knowledge of eye health and available services** by:

- broadcasting on radio/TV spots in the whole country
- distributing posters and leaflets about eye diseases to eye units and health centres
- advertising through the medium of TV, based on interviews with ophthalmologists
- using screening camps to increase knowledge of eye care.

Conclusion

Barriers to the use of cataract services will only be removed with time, community education, and reduced poverty. In the meantime, quality medical care, delivered in a way that is sensitive to the needs of the patients, and returning good outcomes to the community, will form the basis of better uptake of cataract surgery in the future.

Acknowledgements

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CASE STUDY NIGERIA

Increasing an existing

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Background

Community-directed treatment with ivermectin (CDTI) is the main strategy of the African Programme for Onchocerciasis Control (APOC). It has enabled the programme to reach remote and underserved communities where onchocerciasis is endemic. With CDTI, the community is involved in key decisions about how the drug is distributed and selects the distributor. In this way, a relationship of trust is established between provider and beneficiary. This provides an entry point for expanding activities dedicated to the prevention of blindness.

Christian Blind Mission International (CBMI) began working with the government of Nigeria in 1995 on their onchocerciasis programme. In 2003, this collaboration was broadened to address the prevention of blindness. The structure provided a way to reach the people living far from eye care facilities (in many states, these facilities exist only in the urban centres). In addition to strengthening the eye care services, efforts were made to create awareness and a demand for cataract services amongst rural dwellers. The programme described in this article aims to organise outreach programmes in northern Nigeria and falls within the authority of the Ministries of Health of the states of Kano, Jigawa, Yobe, Taraba, and the Federal capital territory, Abuja.

Outreach centres and services provided

In each state, at least one outreach activity is held every year. Each state chooses a suitable site to reach as many people as possible.

In 2004, a total of 632 eyes with blinding cataract were operated; this figure increased to 768 in 2005. In 2006, between January and July, 1,920 eyes with blinding cataract have been operated. In all these cases, an IOL was inserted.

During these outreach camps, trained

Figure 1. Map showing the states where CBMI works with the Ministries of Health

the use of cataract services: using eye care structure in Nigeria

ophthalmic nurses also attended to trachoma trichiasis patients. This supplements the regular eyelid surgery camps organised by the states. More than 500 eyelids with trachoma trichiasis were operated in 2005.

All the patients operated during outreach activities are reviewed at the site of the outreach. They are asked to return to the clinic one week after discharge, and again after six weeks. If there is any problem, they are asked to return immediately. Similarly, if the patients run out of medicines, they are advised to go to the clinic and not to wait for the appointed date. In certain cases, the ophthalmic nurse travels with the patient from his or her area to ensure proper follow-up.

Using the river blindness control structure to create demand for cataract surgery

The CDTI structure is used for the distribution of ivermectin (Mectizan®) drugs to all community members in the endemic areas. Since the distributors are volunteers selected by the communities, and reside within the communities we found that, with additional training, they could take on additional responsibilities. They attended a two-day primary eye care training programme, including one day of field practice, on how to recognise and refer preventable or curable eye diseases prevalent in the communities.

This category of workers has been helpful in identifying cataract patients and referring them for surgery during the outreach programmes. They undertake the following activities:

- creating awareness about cataract blindness among the rural dwellers, using local languages
- identifying the cataract blind persons during annual house-to-house distribution of the drug
- informing the local government co-ordinator of the blindness prevention programme about the number of cataract blind persons identified in each village
- educating the clients about modern treatments, which yield better results, and discouraging them from accessing the traditional couching technique for cataract, which is widely used and dangerous
- informing the clients of the costs of the operation; this is usually shared between the patient, the local government area (LGA), the state government, and CBMI, so that the individual is expected to pay only what he or she can afford
- breaking down barriers to the uptake of such services; this is achieved by reassurance, by escorting patients to the venue of the surgery, and by ensuring that all is accomplished properly. In this way, results will speak for themselves, persuading even the pessimists in those communities
- reminding the clients to go back for periodic review (post-operative care).

Roles of partners in the outreach programmes

The Ministry of Health organises the outreach programme. Its role is also to:

- create awareness by linking up with the LGAs and communities
- screen all cataract blind patients to identify those to be operated
- provide the facility and power source for use during activities
- provide hospitality for the team
- participate in operating (where they have an ophthalmologist)
- determine the outreach centres
- ensure LGA and community involvement
- plan annually for regular and consistent visits to outreach centres.

LGAs are directly responsible to the people in the communities. Their role is to:

- provide the necessary publicity
- provide mats and money for food during the eye camps; this applies to those instances when the LGA has directly sponsored camps to be organised in its domain
- participate in all activities before and during the outreach.

The community members with eye problems:

- use their own resources to reach the site of the outreach
- provide for their own subsistence over the number of days they will spend at the surgical camp site.

The host community:

- mobilises volunteers for crowd control and to assist in carrying patients to and from the theatre.

Influential individuals and groups contribute to the success of the camp by:

- organising some of these programmes
- directly sponsoring patients
- allowing their houses to be used by the entire team.

The international organisation, CBMI, provides the surgery team, usually from CBMI-assisted eye projects, to perform the operations during the outreach programme. The team works to ensure the following:

- advocacy and dissemination of information before the arrival of the team
- patient satisfaction with the services provided
- maximum output during outreaches
- minimum waiting period for the patients
- judicial use of time and facilities
- effective use of the personnel
- availability of equipment and consumables
- affordability of services so that no willing client is denied the services.

Musa Goyol

Outreach surgery camp in progress. NIGERIA

Cost-sharing and sustainability

Patients are expected to pay some amount for the cataract services that they will receive, which will depend on the cost-sharing formula chosen for a particular outreach. In determining the cost that patients are to pay, consideration is given to the very poor, poor, and rich patients. In most cases, the majority of beneficiaries are poor. This makes it very difficult to establish a dividing line to categorise or segment the payment. Subsidy is provided across the board to enable patients to take up the services. In a few instances, full sponsorship helps very poor patients to benefit from the operation free of charge.

Outcomes and lessons learnt from outreach activities

We have noticed some positive developments arising from outreach activities. For example, states are identifying personnel to be trained as ophthalmologists, so as to fill this gap in human resources. In several states, individuals and organisations have sponsored cataract surgery camps for the benefit of community members: in 2005, more than 500 cataract blind patients were beneficiaries under such gestures.

The main challenges we have faced are:

- poor mobilisation in areas non endemic for onchocerciasis, leading to poor utilisation by patients
- lack of steady supply of electricity
- inadequate logistic arrangements
- free eye camps threatening the sustainability of permanent eye hospital services.

How have we coped with these challenges? Firstly, an advance team from the VISION 2020 Support Programme arrives at the camp venue to ensure that adequate mobilisation and effective arrangements are made before the arrival of the surgery team. Secondly, plans are underway to procure a stand-by portable generator to complement the ones provided by the states during eye camps.

Conclusion

This case study demonstrates how eye care services have been extended by using the entry point of an existing prevention of blindness infrastructure. This was facilitated by a productive relationship between the state government health authorities and an international organisation.

Rapid assessment of avoidable blindness


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Introduction

The planning of eye care programmes requires data on the prevalence and causes of blindness. Unfortunately, programme planning is often hampered by the lack of data, because no surveys have been conducted in the area or the surveys are too old to be relevant. Programme planners are often reluctant to plan surveys, as they are believed to be expensive, time-consuming, and complicated. The Rapid Assessment of Avoidable Blindness (RAAB) has been developed as a simple and rapid survey methodology that can provide data on the prevalence and causes of blindness. So far, RAAB has been successfully undertaken in Kenya,[1] Bangladesh,[2] the Philippines, Botswana, Rwanda, Mexico, and China (personal communication). RAAB is an updated and modified version of the Rapid Assessment of Cataract Surgical Services (RACSS).[3]

The main aims of RAAB are:

- to estimate the prevalence and causes of avoidable blindness and visual impairment in people aged 50 and above
- to assess cataract surgical coverage
- to identify the main barriers to the uptake of cataract surgery
- to measure outcome after cataract surgery.

Using sound epidemiological methods, these data are used to design and monitor eye care programmes in the surveyed area.

RAAB focuses primarily on the prevalence of avoidable blindness, which is blindness due to cataract, refractive errors, trachoma, onchocerciasis, and other corneal scarring. This is because the aim of VISION 2020: The Right to Sight is to eliminate 80 per cent of avoidable blindness by the year 2020. RAAB is rapid, because it only includes the over-50 age group, where the prevalence is highest,[4] so that sample size requirements are minimised. RAAB is simple, because it uses straightforward sampling and examination techniques, and data analysis is automatic and does not require a statistician. RAAB is relatively cheap, as it does not take a long time, does not require expensive ophthalmic equipment, and can be carried out by local staff.

RAAB in a nutshell

A RAAB is ideally carried out at the level of a district or province that has a population size of 0.5 to 5 million people. The sample size required for a RAAB is usually between 2,000 and 5,000 people. Clusters of people to include in the survey are randomly selected from across the survey area. Each day, a team visits one population unit (preferably an enumeration area used by the census office, which is a small, clearly demarcated area with a known population, often corresponding to a village or a town suburb). The team randomly chooses a segment of this unit and goes door to door until it has visited 50 people aged over 50 (the cluster). All selected people undergo visual acuity (VA) screening with a tumbling E chart and their lenses are examined. When the VA is lower than 6/18, an ophthalmologist or ophthalmic clinical officer determines the main cause. The information collected in the RAAB is used to estimate the prevalence and causes of blindness in the survey area. Data from a RAAB can also be used to assess outcome after cataract surgery, barriers to cataract surgery, and cataract surgical coverage.

Sampling for a RAAB survey

Sample size requirements

The number of people needed for the survey is calculated using an automated programme within the RAAB software package. The required sample size is largely determined by the expected prevalence of blindness in the area, which can be estimated from existing surveys or from the WHO estimates for the region.[5]

Selecting clusters within the survey area

It is not possible to include all the people in the survey area in your sample, therefore clusters of people need to be selected for the survey. The RAAB software package contains an automated programme to select a list of population units for the survey from the complete list of population units in the area (which is called the sampling frame). Sampling is effected through probability proportionate to size, so that population units with a larger population size have a greater chance of being included than those that are smaller.

Selecting households within clusters

The quality of surveys depends to a large extent on how well the selection of individuals occurs within clusters. If blind people are more likely (or less likely) to be included, then the prevalence of blindness in the survey will not reflect the true prevalence in the area. In RAAB, households within clusters are selected through compact segment sampling.[6] A map is obtained of the population unit, showing major landmarks and the approximate distribution of neighbourhoods and households (Figure 1). If no map is available, then the village members can create one. The area is then divided into segments, so that each segment includes approximately 50 people aged over 50. For instance, if 300 people aged over 50 live in the area, it will be divided into six segments. One of the segments is chosen at random by drawing lots.

The team, accompanied by a village

Figure 1. An example of compact segment sampling depicted on a map

guide, then visits all households in the segment door-to-door, until 50 people aged over 50 are identified. If the segment does not include 50 people aged over 50, another segment is chosen at random and sampling continues. If people are not available when the team arrives at the house, the team should revisit them so that they can be screened. This compact segment sampling is less subject to bias and has therefore replaced the 'random walk' method that was used in RACSS.

Ophthalmic examination

All eligible people undergo a standardised ophthalmic examination in their households. The team measures a distance of 3 and 6 meters with a rope, marking these on the floor. Visual acuity (VA) is measured with a Snellen tumbling E chart, using optotype size 18 (60) on one side and size 60 (200) on the other side at a 6 or 3 metre distance. This allows each eye to be classified as:

- can see 6/18
- cannot see 6/18 but can see 6/60
- cannot see 6/60 but can see 3/60
- cannot see 3/60 but can see 1/60
- light perception
- no light perception.

If the person cannot see 6/18 in either eye with available correction, pinhole vision will also be measured. It is difficult to measure vision accurately and one must ensure that the subjects clearly understand what is required of them in the visual acuity test.

The lens status of all participants is assessed by both torch and distant direct ophthalmoscopy, by an ophthalmologist or ophthalmic clinical officer in a shaded or dark environment. All eyes that cannot see 6/18 with available correction are examined with a direct ophthalmoscope (and with a portable slit lamp if available) to assess the cause of the visual impairment. Only the primary cause of blindness or visual impairment is recorded. If there are two or more primary disorders, equally contributing to the visual loss, then the WHO convention is to record the cause that is easiest to treat or to prevent. All information is recorded on a standardised form. People who have a vision-impairing cataract are asked why they have not undergone cataract surgery, and up to two responses are marked per person in pre-coded categories. Those who have undergone cataract surgery are asked about the details of their operation (e.g. place, age, type of operation, satisfaction). People with a treatable eye condition should be referred for appropriate treatment.

Teams and training

Each team should consist of one ophthalmologist or ophthalmic clinical officer, who can diagnose the eye diseases, and of one assistant who can measure visual acuity. The teams will be accompanied every day by a local village guide. It is useful to have between two and five teams to minimise the duration of fieldwork. All teams should be trained for at least four days, including a field practice where all teams cover one selected cluster. Training should be undertaken by someone experienced in using the RAAB methodology. The survey will usually take between 4 and 12 weeks, depending upon the sample size and the number of teams. The cost of the survey will be largely determined by salaries, allowances, and transport, but is usually between UK £10,000 (US $19,000) and UK £15,000 (US $28,500).

Hannah Kuper

Measurement of visual acuity in a village. KENYA

Data entry and data analysis

A programme has been developed in Visual FoxPro version 7.0© for data entry and automatic standardised data analysis for RAAB. In-built consistency checks and validation through double entry are used to identify and correct any errors in recording and data entry. Automated data analyses are performed on the cleaned data set. These produce estimates of:

- prevalence of blindness, severe visual impairment (SVI), and visual impairment (VI)
- age- and sex-adjusted prevalence of blindness, SVI, and VI
- prevalence of avoidable blindness, SVI, and VI
- causes of blindness, SVI, and VI
- cataract surgical coverage
- outcome after cataract surgery
- causes of poor outcome
- satisfaction with cataract surgery
- barriers to uptake of cataract surgery.

All tables report results for men and women separately, as well as together.

Feedback and reporting

There is no point in conducting a survey unless the data are going to be used for programme planning or monitoring. A report of the RAAB, including the results, should be written and circulated to stakeholders in the programme. The results from the RAAB should be used to develop a VISION 2020 action plan, to plan the cataract surgical services required, for instance, or to identify problems, such as poor outcomes after surgery or significant barriers to surgery, so that strategies can be developed to overcome these difficulties.

Conclusions

RAAB provides the necessary data to plan eye care programmes and also to monitor programmes, if repeated every three to five years. RAAB has been successfully undertaken in Kenya,[1] Bangladesh,[2] the Philippines, Botswana, Rwanda, Mexico, and China.

What RAAB does not do

Since examinations in RAAB are conducted door-to-door, the diagnostic facilities are limited, and it may not always be possible to accurately diagnose causes of posterior segment disease. RAAB only includes people aged over 50, therefore the prevalence of blindness in people aged under 50 cannot be estimated. RAAB measures the prevalence and causes of visual impairment, but it does not assess active trachoma, trichiasis, or infection with onchocerciasis when these are not vision-impairing.

If you are interested in conducting a RAAB in your setting, or if you have further queries about conducting a RAAB, please contact Hans Limburg or Hannah Kuper (Email: hannah.kuper@Lshtm.ac.uk). We strongly encourage you to hire experienced professionals to assist in the preparation and training for the RAAB. This will improve the reliability and quality of your survey data.

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BIOMETRY

How to avoid mistakes in biometry

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Introduction

The refractive power of the human eye depends on three factors: the power of the cornea, the power of the lens, and the length of the eye. Following cataract surgery, only the power of the cornea and the length of the eye are relevant. If both of these variables are known, it is possible to calculate what lens power will give the best refraction. Biometry is the process of measuring the power of the cornea (keratometry) and the length of the eye, and using this data to determine the ideal intraocular lens power. If this calculation is not performed, or if it is inaccurate, then patients may be left with a significant refractive error.

On 8th February 1950, Harold Ridley implanted the first intraocular lens (IOL), following an earlier extracapsular cataract extraction. Post-operatively, the patient's refraction was -24.0/+6.0 x 30 degrees. Although Mr Ridley's choice of material was inspired, his patient did not enjoy the benefits of modern biometry.

Over fifty years later, despite sophisticated technology and intelligent software, one frequently encounters biometry mistakes or 'surprises'. Most are avoidable and most are due to human error. This article will examine the steps involved in biometry and the ways in which mistakes can be minimised, based on feedback from ophthalmic staff in busy units.

NB Although accurate biometry represents the ideal, it is not always possible. In communities with a low prevalence of axial ametropia, an IOL of a standard power will give good results in at least half the population.[1]

Steps in selecting the correct IOL

1 Identifying the refractive needs of the patient

Emmetropia will be the goal for most patients, but some may benefit from being left intentionally myopic post-operatively (or, rarely, hypermetropic), depending upon their preference and the refraction of the other eye. **Anisometropia should be kept below 3 dioptres**. The need for reading glasses should be explained and the patient made aware of the options.

2 Measuring the axial length of the eye

The measurement of axial length measurement has the greatest potential for error in calculating IOL power. Traditionally, contact A-scan ultrasonography is used. This measures the time taken for sound to traverse the eye and converts it to a linear value using a velocity formula. Part of the ultrasound beam reflects back from each surface in the eye – cornea, anterior lens, posterior lens, and retina. The reflected beam is translated into an image showing lines (spikes) for each surface. The distance between the corneal and retinal spikes gives the axial length of the eye.

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Figure 1. Photograph showing technique for applanation A-scan biometry

More recently, non-contact laser interferometry has been developed (IOL Master). It is more precise,[2] combines axial length and keratometry, and enables different formulae to be used,[3] but it may be inaccurate for patients with axial or dense cataracts or gross astigmatism. It is also expensive. However, this method is well suited to some special conditions. These include extremely short eyes, very long eyes with posterior staphylomata, eyes containing silicone oil, and pseudophakic eyes.

As a rule, biometry is done using an applanation probe in contact with the cornea, but the immersion method[4] may also be used. In the immersion method, a scleral (Prager) shell is placed between the eyelids and centred on the cornea of the supine patient. This method avoids any corneal compression (and thus a falsely short axial length) and gives high quality, consistent spikes.

The alignment of the A-scan is vitally important. If the alignment is incorrect, the length of the eye will be underestimated. Most systems rely on the patient fixing on a target – usually a light in the probe. Patients with poor vision, whether from cataract or from some other pathology, are less likely to fix accurately, and are more prone to biometry errors.

Tips for accurate measurement of axial length (using applanation):

- ensure the machine is calibrated and set for the correct velocity setting (e.g. cataract, aphakia, pseudophakia)
- the echoes from cornea, anterior lens, posterior lens, and retina should be present and of good amplitude
- misalignment along the optic nerve is recognised by an absent scleral spike
- the gain should be set at the lowest level at which a good reading is obtained
- take care with axial alignment, especially with a hand-held probe and a moving patient (as described above)
- don't push too hard – corneal compression commonly causes errors
- average the 5-10 most consistent results giving the lowest standard deviation (ideally < 0.06 mm)
- errors may arise from an insufficient or greasy corneal meniscus due to ointment or methylcellulose used previously.

Take note of eyes that are very short (less than 22 mm) or very long (more than 25 mm). Axial length errors are more significant in short eyes and a posterior staphyloma may be present in a long eye. Look out for the unexpected result, for example an axial length of 27 mm in a patient with a +4.00 D refractive error. Always measure both eyes and repeat if the difference between eyes is greater than 0.3 mm, or if consecutive measurements differ by more than 0.2 mm.

3 Measuring the power of the cornea

Again, accuracy is essential, as an error of 0.75 D in the keratometry will result in a similar post-operative error. Keratometry may be carried out manually or using an automated or hand-held device.

Tips for accurate manual keratometry:

- calibrate and check the accuracy of the keratometer
- use a dedicated single instrument that is known to be accurate
- don't touch the cornea beforehand and ensure a good tear film
- adjust the eyepiece to bring the central cross-hairs into focus
- make sure that the patient's other eye is occluded and that the cornea is centred
- **take an average of three readings, including the axes**
- if high or low results are encountered (< 40.00 D or > 48.00 D), it is advisable to have a second person check the measurements
- **repeat if the difference in total keratometric power between the eyes exceeds 1.50 D**
- in a scarred cornea, use the fellow eye or average the results.

4 Using the appropriate formula

The Hoffer Q, Holladay I, and SRK/T formulae are all commonly used, but the SRK I and II regression formulae are now regarded as obsolete.[5] More recent formulae, such as the Holladay II or Haigis, are not currently built into biometry software. Where audit software is in use, the personalisation of calculation constants can increase accuracy.[6] Table 1 indicates which formulae to use.

Table 1. Range of axial length and preferred formula

Axial length (mm)	Formula
< 20 mm	Holladay II
20-22 mm	Hoffer Q
22-24.5 mm	SRK/T / Hoffer Q/ Holladay (average)
> 24.5-26 mm	Holladay I
> 26 mm	SRK/T

5 Difficult eyes

Extremely **dense cataracts** create difficulties, as they absorb sound as it passes through the lens. A higher gain setting may be necessary to achieve adequate spikes. **Posterior staphylomata** in myopic eyes not only cause an elongated globe, but often tilt the macula as well so that the ultrasound beam is deflected. In these cases, it may be necessary to add the A-scan anterior chamber depth measurement to vitreous depth taken from a B-scan.

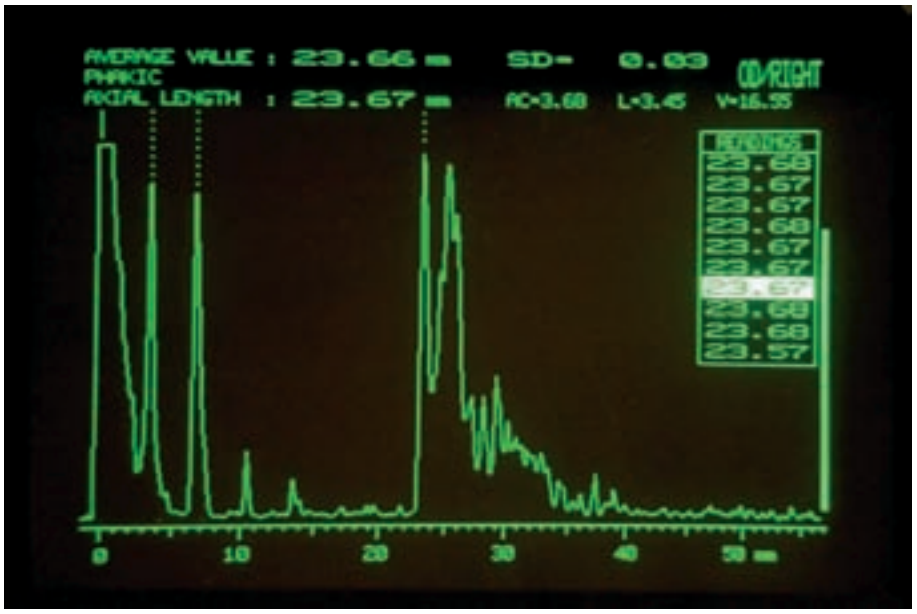

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Figure 2. A-scan of the phakic eye
Note the 5 high-amplitude spikes and the steeply rising retinal spike separated from the scleral spike

- ***initial spike (probe tip and cornea)***
- ***anterior lens capsule***
- ***posterior lens capsule***
- ***retina***
- ***sclera***
- ***orbital fat***

6 Why things go wrong

No matter how good the system, people will still make mistakes. Some reasons include:

- people in a hurry
- lack of training or accessible guidelines
- reliance on others
- technical failure (rarely)
- human error (often).

Some common mistakes (collected from the UK and overseas departments):

- wrong A-constant selected
- wrong formula used
- wrong K-readings entered by hand (90 degrees out)
- biometry print-out stuck in wrong patient's notes
- incorrectly labelled IOL
- wrong patient in theatre
- reversed IOL optic
- wrong IOL implanted (25.5 D implanted instead of 22.5 D or +30 D instead of +3.0 D).

Some errors of omission include:

- no biometry at all
- no spectacle prescription or focimetry available
- no IOL available on the day
- not taking account of the other eye
- not discussing the intended outcome with the patient.

Another factor to consider is the post-operative position of the IOL. Inadvertent placement in the sulcus will cause a 0.75 D myopic shift. If an anterior chamber IOL has to be used, the A-constant will be different. If all else fails, blame the machine! Different biometry machines may give different results, which can be confusing (e.g. A-scan biometry and IOL Master).

In some high-volume clinics, the time required for biometry exceeds the time taken for surgery. However, if you are going to do biometry, you have to do it properly and thoroughly. It is better to have a few well-trained and experienced members of staff who can get consistent results, than to have many people with limited training and experience.

Departments should aim for consistency in their biometry and audit their results. Mistakes are easy to make, but difficult (and sometimes expensive) to rectify. The following list sums up some lessons that can be learnt from others' mistakes:

- slow down
- train and certify your biometry staff
- follow guidelines
- don't rely on others
- watch out for the unexpected
- learn from mistakes, particularly any eyes with error greater than 2 dioptre
- audit your outcomes.

If you are using biometry, 80 per cent of eyes should be within 1 dioptre of their intended refraction. Try to identify any issues that are leading to consistent errors.

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Useful resources: increasing uptake and generating demand for cataract services

Grignon J, Banzi J, Musoe B, and Hall C. Bridging strategies manual. Kilimanjaro Centre for Community Ophthalmology (KCCO), December 2006.

VISION 2020 Action Plan CD, Chapter on generating demand. **www.who.int/ncd/vision2020_actionplan/contents/5.3.htm**

Vanneste G. Breaking down barriers – how to increase the cataract surgical rate. CBMI 2001.

Limburg H. Monitoring cataract surgical outcomes. ICEH 2005. Available free of charge from ICEH.

***Community Eye Health Journal* – back issues**

Volume 5, Issue 9, 1992 Cataract: a challenge for public health ophthalmology

Volume 5, Issue 10, 1992 Audit results of cataract surgery

Volume 11, Issue 25, 1998 A global initiative for the elimination of avoidable blindness: cataract surgical coverage

Volume 13, Issue 34, 2000 VISION 2020: the cataract challenge

Volume 13, Issue 35, 2000 Cataract surgery outcomes: a priority agenda item

Volume 15, Issue 44, 2002 Importance of monitoring cataract surgical outcomes

Volume 16, Issue 48, 2003 Sutureless non-phaco cataract surgery: a solution to reduce worldwide cataract blindness?

Volume 17, Issue 50, 2004 Childhood cataract

Relevant publications from the KCCO website, include:

Lewallen S *et al.* Willingness and ability to pay for cataract surgery: a study in Tanzania. Links at **www.kcco.net/annquartrep.html** PDF at **www.kcco.net/kenyan_articlespdf.pdf**

Ndegwa LK *et al.* Barriers to utilization of eye care in Kibera slums of Nairobi. East Afr Med J 2005;82: 506-8. PDF at **www.kcco.net/List_of_articles_on_eye_care_in_Tanzania.pdf/**

Geneau R *et al.* The social and family dynamics behind the uptake of cataract surgery: findings from Kilimanjaro Region,Tanzania. Br J Ophthalmol 2005;89: 1399-402.

Lewallen S *et al.* Increasing cataract surgery to meet VISION 2020 targets; experience from two rural programmes in East Africa. Br J Ophthalmol 2005;89: 1237-40.

Lewallen S *et al.* Willingness to pay for cataract surgery in two regions of Tanzania. Br J Ophthalmol 2006;90: 11-13.

Mwende J et al. Delay in presentation to hospital for surgery for congenital and developmental cataract in Tanzania. Br J Ophthalmol 2005;89: 1478-82.

Publications which can be downloaded from the VISION 2020 e-resource include:

Community Outreach Initiatives; paragraph on Social Marketing and Demand Generation, page 12, at **http://laico.org/v2020resource/files/Communioutreachmodule.pdf**

Management Principles and Practices; contributing factors table, page 12, at **http://laico.org/v2020resource/files/Management module.pdf**

Suppliers' addresses

CBMI Christian Blind Mission International, Nibelungenstrasse 124, Bensheim 64625, Germany. Email: **julia.wolfram@cbm-i.org**

ICEH International Resource Centre, International Centre for Eye Health, LSHTM, Keppel Street, London WC1E 7HT, UK. Email: **sue.stevens@Lshtm.ac.uk**

Aravind Communications/LAICO, 72 Kuruvikaran Salai, Gandhinagar, Madurai 625 020, Tamil Nadu, India. Email: **communications@aravind.org**

World Health Organization, Prevention of Blindness and Deafness, CH-1211 Geneva 27, Switzerland. Email: **pbd@who.int**

KCCO, Tumaini University/KCMC, PO Box 2254, Moshi, Tanzania, Tel: 255 27 2753547, Fax: 255 27 2753598, Email: **kcco@kcco.net**

NEWS AND NOTICES

Courses and conferences

The Inaugural World Congress on Refractive Error and Service Development
14-16 March, 2007. **Theme:** Meeting the Challenges of Refractive Errors in the 21st Century. **Venue:** The International Convention Centre, Durban, South Africa. **Hosted by:** The International Centre for Eyecare Education (ICEE) **Information: www.icee.org**

Working with management to get the support you need to achieve VISION 2020 goals: a course for ophthalmologists
April 16-20, 2007. **Venue:** KCCO, Tanzania. **Objectives:** To provide a basic understanding of management principles to ophthalmologists so that they can work with managers and other clinical and non-clinical staff to reach their VISION 2020 targets, improve the working environment, and improve service quality. **Target audience:** Ophthalmologists who are in charge of eye departments. **Information and admission procedures:** Visit the KCCO website (**www.kcco.net**) or contact Genes Mng'anya, KCCO Courses Administrator – Email: **genes@kcco.net**

Eighth General Assembly of the International Agency for the Prevention of Blindness
28 July-2 August, 2008. **Theme:** Excellence and Equity in Eye Care. **Venue:** Centro de Convenções Rebouças, Sao Paulo, Brazil. **Information:** Email: **agency@lvpei.org**

International Ophthalmic Nurses Association Annual Conference 30-31 March, 2007. **Venue:** University of Swansea, South Wales, UK. Information: Northern Network Events. Email: **gill@glasconf.demon.co.uk**

Bridging Communities and Eye Care Providers to Achieve VISION 2020 in Africa
12-16 November, 2007. **Venue:** Kilimanjaro Centre for Community Ophthalmology, Tanzania. **Objectives:** To develop the skills to design, implement, and monitor strategies for increasing utilisation of services by the population in need. **Target audience:** Eye care programme managers (MoH, NGO, service groups), trainers, key decision-makers of national prevention of blindness programmes. **Information and admission procedures:** Visit the KCCO website (**www.kcco.net**) or contact Genes Mng'anya, KCCO Courses Administrator – Email: **genes@kcco.net**

Diploma in Community Eye Health
14 February-25 May 2007. **Venue:** ICEH at the London School of Hygiene and Tropical Medicine, 8 Bedford Square, London WC1B 3RE UK. **Objectives:** Overview of the major blinding eye diseases and the VISION 2020 initiative. Weeks 1 to 5 focus on the control of blinding eye diseases. Weeks 6 to 10 are spent working on a strategy document outlining a plan which will be implemented on participants' return to their home countries. Weeks 11 to 15 aim to build skills to assess, plan and develop the human, financial and technical resources for the prevention and control of blindness, with particular emphasis on a VISION 2020 project. **Target audience:** Eye care professionals (including ophthalmologists, optometrists, and project managers) who want to receive training in Community Eye Health, but cannot be away from their place of work for one year. **Information and admission procedures:** Visit the London School of Hygiene and Tropical Medicine's Website: **www.lshtm.ac.uk/prospectus/short/sdceh.html** or Short Courses at **ShortCourses@Lshtm.ac.uk**.

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Next issue

Lutful Hussain

The next issue of the *Community Eye Health Journal* will be on the theme **Field research for VISION 2020: summaries from research projects**