

# REFRACTIVE ERRORS AND LOW VISION

## The Role of Optometry in VISION 2020

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The global initiative, VISION 2020: The Right to Sight, established by the World Health Organization (WHO) and the International Agency for the Prevention of Blindness, has created valuable and effective collaborations of organisations involved in a wide range of eye care and community healthcare activities aimed at the elimination of avoidable blindness and impaired vision.

VISION 2020's major priorities are cataract; trachoma; onchocerciasis; childhood blindness, and refractive error and low vision. These have been selected not only because of the burden of blindness that they represent but, also, because of the feasibility and affordability of interventions to prevent and treat these conditions.

It is only recently that uncorrected refractive error has achieved prominence as a major cause of functional blindness and significantly impaired vision, as a result of landmark population-based studies in adults, children and in post-cataract patients.

Apart from individuals who have taken an active role in the elimination of diseases such as onchocerciasis or have been in cataract teams, optometrists have had little opportunity to take part in the front line elimination of four of the major, preventable blindness-producing conditions targeted



*Vision restored!*

*Photo: Pak Sang Lee*

by VISION 2020. The realisation of the impact of uncorrected refractive error has provided the opportunity for optometry to play a major part in alleviating vision loss for those most in need.

The need to mobilise optometry to deal with uncorrected refractive error has been accompanied by the possibility of better integration of optometry into prevention of blindness in general, with some major benefits in areas such as:

- Teaching eye care personnel, especially in refraction and low vision care.
- Providing screening and vision care services at secondary and tertiary levels.
- Detection and management of potentially blinding diseases such as cataract, diabetes and glaucoma.
- Research into the understanding of global eye care needs and solutions, especially in vision correction and vision care service delivery.
- Building economic and logistical models of self-sustainable eye care.

## The Impact of Uncorrected Refractive Error

Visually disabling refractive error affects a significant proportion of the global population, occurring in both genders, in all ages and in all ethnic groups.

The most common cause of visual impairment, and the second leading cause of treatable blindness,<sup>1</sup> uncorrected refractive error has severe social and economic effects on individuals and communities, restricting educational and employment opportunities of otherwise healthy people. The duration of the effect is also significant – refractive error can account for twice as many blind-person-years compared to cataract, due to the earlier age of onset.<sup>2</sup>

The need is very great for both children and adults. Studies have shown that refractive error in children causes up to 62.5% of blindness ( $\leq 6/60$  in the better eye) – in Chile,<sup>3</sup> 22% in Nepal,<sup>4</sup> 77% in urban India,<sup>5</sup> and 75% in China.<sup>6</sup> For visual impairment in children ( $\leq 6/12$  in the better eye), refractive error is responsible for 55% in Chile, 86% in Nepal, 93% in China, 70% in rural India,<sup>7</sup> and 83% in urban India.<sup>5</sup> What is also disturbing is the amount of this refractive error that is uncorrected on presentation – 46% in Chile, 92% in Nepal, 58% in China, 86% in rural India. The burden even reaches to developed countries, with uncorrected refractive error causing 25% of all blindness ( $<6/60$ ) in an Australian adult population, and 56% of visual impairment ( $<6/12$ ).<sup>8</sup>

The burden of refractive error is set to grow alarmingly due to an increase in myopia in both the developed and developing world – especially in urbanised East Asians, such as the Chinese populations in Hong Kong, Singapore and Taiwan.<sup>9–11</sup>

## Refractive Error and VISION 2020

The impact and importance of uncorrected refractive error has now been recognised by VISION 2020. WHO established a Refractive Error Working Group (REWG) as part of global VISION 2020 activities, in recognition of this important facet of international eyecare. The REWG is now developing international strategic plans and policies to eliminate uncorrected refractive error.

## Optometry's Role in Correcting Refractive Error

The good news is that while refractive error is amongst the most common causes of blindness and visual impairment, it is also the easiest to 'cure'. Refractive error can be simply diagnosed, measured and corrected, and the provision of spectacles is an extremely cost-effective intervention, providing immediate correction of the problem.

Throughout the world, optometry has been the major provider of vision correction, but usually from a private practice setting. Public health optometry has not reached the communities that are in most need, in any organised way. Despite this, on their own initiative, thousands of private optometrists worldwide have



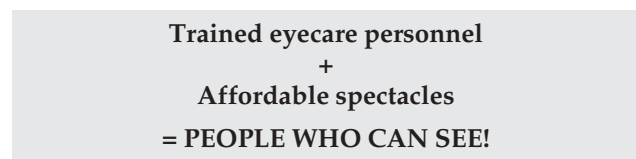
*Eye examination by an ICEE optometrist in a remote location in East Timor*

*Photo: Brien Holden*

regularly visited communities in need, to provide vision care and dispense spectacles. The opportunity now is for optometry to develop a concerted effort to create local capacity in these communities through service delivery, in collaboration with its partners in VISION 2020, by creating human resources and by helping to develop the infrastructure needed – the three cornerstones of the VISION 2020 programme.

## What is Needed?

The way to eliminate uncorrected refractive error is through the development of all these aspects of a self-sustaining system, including personnel to provide eye care services; and spectacles, to correct vision.



In most developed countries the optometrist to population ratio is approximately 1:10,000. However, in developing countries the ratio is 1:600,000, and much worse in many rural areas – up to millions of people per optometrist. This lack of practitioners is the main reason for high rates of vision problems due to uncorrected refractive error in developing countries. The 'blindness' rate in many developing countries, especially in Africa, is 7 times higher, than in developed countries at 1.4%.

In order to deliver good quality eye care to countries where the need is greatest, there needs to be a steady but substantial increase in the number of eye care personnel trained in refraction and vision correction. The current desperate situation in many countries cannot wait for advanced optometry to develop, but requires optometry to take a major role in training mid-level personnel in refractive care. Whether it is the

world's newest country, East Timor, or Ethiopia with its 70 million people, both without any optometrists, interim measures using nurse-refractionists or ophthalmic or optometric technicians that refract are essential.

Many make the issue of refraction and vision correction too simple. Why not just use subjective trial and error? The main reason is that it does not work. Children accommodate, myopia is overcorrected, and hyperopia is undercorrected. The second reason is that both adults and children will not wear spectacles that hurt their ears, look strange or 'strain their eyes' – even if they are free. It is a waste of time, resources and money to do it the wrong way! Doing it the right way means an accurate refraction (by a refractionist using either a retinoscope or refractometer) and the correct ISO/ANSI standard spectacles that are comfortable and attractive. Affordable spectacles can be provided easily through mass-distribution of 'ready-made' spectacles and the establishment of low-cost local laboratories for 'tailor-made' spectacles.

International optometry and opticianry have important roles to play in this task. Traditionally, these groups have been primarily involved in the private sector, generally looking after wealthier people in the community. But progressive leadership in optometry sees an ever-increasing role in the development of training and continuing education programmes for all levels of available eye care personnel; in the establishment of infrastructure; in the development of effective models and programmes; in the delivery of eye care services to meet community needs, and in the funding needed for the provision of training and low cost spectacles.

### Optometry as Part of the Eyecare Team

In the first Planning Meeting of the Informal Group on Refractive Error, the participants endorsed 'the inclusion of the correction of visually disabling refractive error as a component of the Global Initiative for the Elimination of Avoidable Blindness – VISION 2020: The Right to Sight', and 'emphasised the need to deliver refraction services as an integral part of general health care systems and comprehensive eye care'.<sup>12</sup>

The need for glasses is also a public eye health opportunity not to be missed. Refractive care provides excellent access to the population for screening of more serious eye problems, such as cataract and diabetes. Primary care screening by optometrists and eye care workers, with optometrists taking care of the more immediate interventions required, and referral for more 'complicated' care, is 'classical' health care delivery.

One effective current model, developed by the LV Prasad Eye Institute in Hyderabad, India, for the efficient and cost-effective delivery of eye care is a community eye care 'team'. For every 1,000,000 people the team has:



*Bifocal spectacles make a difference in Jamaica*

*Photo: Murray McGavin*

- 1 ophthalmologist.
- 4 optometrists.
- 8 eye care workers.
- 8 ophthalmic assistants.
- 16 ophthalmic nurses.

### The Role of Research

As the previous statistics show, there is a significant problem to be faced in addressing uncorrected refractive error. But understanding the scope of the problem, and most importantly, planning how to solve it, requires much more information than these simple numbers. Adequate prevalence data are necessary to determine the regions, population groups and age cohorts most in need of intervention, and, also, to provide the basis from which interventions in the future can be evaluated.

As part of the front line of the eye care team, optometry has a role to play in research – as diverse as the aetiology of the epidemic of myopia in East Asia, to collecting the data needed to design effective eye care interventions – both in refractive error and for other eye care needs. Optometry can significantly contribute to the understanding of:

- Worldwide blindness and impaired vision – the burden and its effects.
- Health care planning.
- Service delivery.
- Outcomes of intervention.

### Refractive Error Study In Children

A series of studies around the world have begun to fill in the gaps in our knowledge of the burden of blindness and impaired vision in children caused by refractive error. The studies address the variation of refractive error with age, gender, race and geographic region, the extent to which it is being corrected, and how the prevalence is changing over time. The

Refractive Error Studies in Children (RESC) have so far been conducted in Nepal, China, Chile and India, using population-based, cross-sectional sampling, consistent definitions and a common methodology. ICEE is currently conducting the RESC study in KwaZulu Natal, South Africa, in conjunction with the National Eye Institute and WHO, and sponsored by CBM International, Sight Savers International and ICEE. At the completion of the African study, data will have been collected on approximately 30,000 children worldwide.

### Self-Sustainability, Refractive Error and Optometry

Two other important contributions that optometry and the optical industry can make to the worldwide fight to eliminate avoidable blindness and impaired vision due to refractive error are:

- Developing the logistics and economics of self-sustaining eye care at the community and institutional levels.
- Mobilising worldwide resources to develop models and create the educational and delivery infrastructure for refractive and general vision care.

First, optometry and opticians need to pass on knowledge of the logistics, supply systems and economic management, that is done so well in private practice, to public health programmes. Thus, spectacle supply can effectively fund more expensive or intensive needs, such as low vision and cataract surgery. An important part of practical and cost-effective eye care systems to communities in need is the understanding that it does not make sense to bring 50% of the population that require refractive services into a hospital setting for refractive care. It makes much more sense to screen, refract and supply spectacles and vision care (including the detection and treatment of minor problems and referral of those with more serious problems) at the community level. Optometry can make a major contribution in supporting eye care at this more convenient and cost-effective level.

Second, the global spectacle industry and optometrists and ophthalmologists who serve the private sector probably generate total revenues of over

\$100 billion. It would be a powerful statement of professional and corporate responsibility if 0.1% of this amount found its way back to help those most in need.

### Conclusion

It should not be necessary for any child to struggle in school, to learn with an uncorrected refractive error. Nor should any older person be called upon to spend thirty or forty years without glasses – reading or sewing or managing a job. Optometry and the optical industry, in its broadest sense, should be able to find the financial resources to give this simplest gift of sight.

Preventable blindness is one of our most tragic and wasteful global problems. Optometry is an essential part of the team that will eliminate this tragedy, by understanding global eye care needs and delivering effective and sustainable vision care to people in need, thereby ensuring their fundamental right to sight.

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# Strategies for Correcting Uncorrected Refractive Errors: The Challenge of providing Spectacles in the Developing World

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Visually disabling refractive error (RE) affects a significant proportion of the global population, occurring in both genders and all ages and ethnic groups. Yet we are only now beginning to realise the size and impact of this global health problem. RE is one of the most common causes of visual impairment, and the second leading cause of treatable blindness.<sup>1</sup> It has severe social and economic effects on individuals and communities, restricting the educational and employment opportunities of otherwise healthy people. The duration of the effect is also significant, as RE has been found to account for twice as many blind-person-years compared to cataract due to the earlier age of onset.<sup>2</sup>

The statistics are staggering. Studies have shown that in children, RE causes up to 62.5% of blindness in Chile,<sup>3</sup> 22% in Nepal,<sup>4</sup> 77% in urban India,<sup>5</sup> and 75% in China.<sup>6</sup> For visual impairment in children, RE is responsible for 55% in Chile, 86% in Nepal, 93% in



*Donated spectacles*

*Photo: Murray McGavin*

China, 70% in rural India,<sup>7</sup> and 83% in urban India.<sup>5</sup> The burden even reaches to developed countries, with uncorrected RE causing 25% of all blindness (<3/60) in an Australian adult population.<sup>8</sup>

In an eye with refractive error (or ametropia), parallel rays of light fail to converge to a sharp focus on the retina. For the patient, this means that their vision is blurred. The error is 'correctable' if a sharp focus can be achieved with the aid of vision correction devices, such as spectacles or contact lenses. Yet many people with refractive error are not aware that there is a cure for their compromised vision, have no-one to provide treatment, or cannot afford the appliances they need.

The way to eliminate global uncorrected refractive error is through the development of all aspects of a self-sustaining system, including human resources to provide eye care services, and spectacles to correct vision.

## **VISION 2020 and the Refractive Error Working Group**

*VISION 2020: The Right to Sight* is a concerted worldwide effort designed to eliminate avoidable

blindness by the year 2020. Established by an alliance of the World Health Organization (WHO), the International Agency for the Prevention of Blindness (IAPB), and the Partnership Committee of the International Non-Governmental Development Organisations, the programme seeks to enable all parties and organisations involved in combating blindness to work in a focused and co-ordinated way.

In February 2000, ICEE made a proposal to the WHO and the IAPB for the establishment of a Refractive Error Working Group (REWG), to be part of the global VISION 2020 activities, in recognition of this important aspect of international eye care. The REWG is now developing international strategic plans and policies to eliminate uncorrected RE. The group is also helping to decide what research is required and in which regions, in order to have adequate data to make an estimate of blindness and impaired vision due to RE.

As the previous statistics show, there is a significant problem to be faced in addressing uncorrected RE. But understanding the scope of the problem, and most importantly planning how to solve it, requires much more information than these simple numbers.

A series of studies around the world aim to provide information on the variation of RE – with age, gender, race and geographic region, the extent to which it is being corrected, and how the prevalence is changing over time. The Refractive Error Studies in Children (RESC) have so far been conducted in Nepal, China, Chile and India. ICEE is currently conducting the RESC study in KwaZulu Natal, South Africa in conjunction with the National Eye Institute and WHO.

The study investigates the prevalence of RE and visual impairment in children 5–15 years old. Approximately 6000 children will be targeted in the study, which will use a mobile eye care team and regional eye clinics to reach communities. At the completion of the African study, data will have been collected on approximately 30,000 children worldwide. This data will be vital to determining the regions, population and age groups most in need of intervention, and will also form the basis from which interventions in the future can be evaluated.



Recording the spectacle lens powers using the focimeter

Photo: Murray McGavin

## Low or No Cost Spectacles

A crucial element of the effective delivery of refractive eye care services is the provision of affordable vision correction devices. While there are a number of options for vision correction (e.g., contact lenses, refractive surgery, etc.), spectacles are the simplest and most inexpensive option. However, in many areas of the world, spectacles are either not available, or too expensive. While having adequately trained practitioners is essential to providing refraction and eye care to communities, this care must be supported with the devices needed to restore sight.

The challenge now is to develop ways of supplying good quality spectacles to communities in need. While there are many schemes which involve spectacle supply (for example, collecting used glasses for distribution to developing countries), for any system to be truly effective, it must be sustainable and long term.

The issues in the provision of spectacles are:

- Quality.
- Supply (ready-made or prescription).
- Distribution.
- Cost.
- Acceptance.

### 1. Quality

The spectacles need to be of the highest possible quality, including lenses which adhere to ISO standards of power, prism, and power variation; frames which are sturdy and with a metal hinge; and a complete pair of spectacles which are lightweight and attractive. Quality of lenses and frames are critical for effective use, especially by children.

In recent studies of spectacle wearers in India, comfort and attractiveness were significant factors in determining wear patterns.

### 2. Supply

In providing spectacles to patients, there is a choice between ready-made and prescription devices. Ready-mades are convenient for the refractionist and patient, and can be used for spherical distance prescription, and reading glasses – where the spherical power difference is less than 0.50D and the cylindrical power less than 0.75D. However, there are issues of cost, availability, quality, re-supply, and applicability.

Prescription spectacles will be needed for approximately 30% of the patient population depending on the criteria used.

Innovative ways of producing prescription spectacles are being investigated. It is anticipated that with a simple system, there will be minimal need for full laboratory set-up and highly trained technicians to provide custom-made prescription spectacles.

### 3. Distribution

While spectacles may be readily available in urban areas, the system must ensure that vision correction devices are also available for patients living in rural and remote areas. It is, therefore, necessary to look at every level of distribution:

- National / Provincial.
- Regional.
- District.
- Community.

Ready-mades can be made available at the community level, while prescription lenses would require a dispensing laboratory within the district, and a technician within the community to fit lenses to frames.

Various delivery models have been devised for the delivery of eyecare and vision correction, e.g., the 'Franchise Model', where potential practitioners are selected, training and provided with spectacle sets. The franchise guidelines could include:

- Minimum number of eye examinations to be provided in schools and villages
- Low cost spectacles
- Upgrading of the franchisee's training and involvement.

### 4. Cost

It is anticipated that the establishment of a self-sustaining system of supply of low cost spectacles will provide funds that can be directed to other programmes, such as education or research. However, funds will be required from existing funding schemes, charities, industry and/or government subsidy – particularly in the early stages of this scheme.

### 5. Acceptance

In some communities there are cultural issues regarding acceptance of spectacles, while in other communities wearing spectacles are considered attractive. Public education is the key to acceptance.

### Conclusion

Avoidable blindness and low vision can restrict



*A selection of 'designer frames' in Jamaica*

*Photo: Murray McGavin*

progress in education, particularly literacy; limit motor development in children; affect mobility; limit career opportunities, and restrict access to information. It is a burden on the community and social and income generating services. By correcting uncorrected refractive error, we can dramatically improve the quality of life and access to education for many people.

Available and affordable spectacles are a major part of this aim. The issues of quality, supply, distribution, cost and acceptance all need to be examined. Then, the best possible plans and programmes can be developed, which will deliver vision to communities in need.

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# Vision Testing for Refractive Errors in Schools

## 'Screening' Programmes in Schools

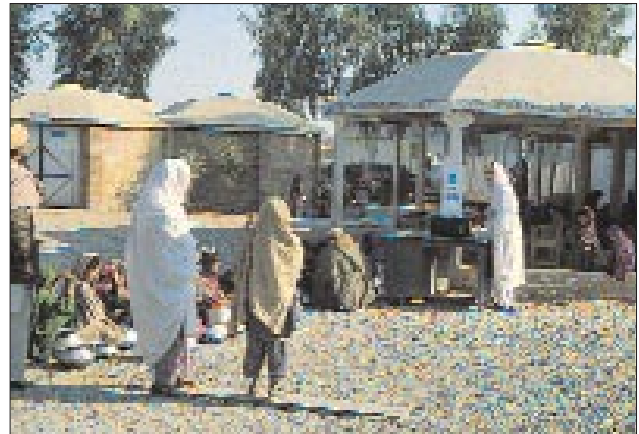
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Uncorrected refractive errors are an important cause of visual impairment in many countries. In developing countries, however, it is often difficult to provide an efficient refraction service for a variety of reasons. The proportion of children who are blind or visually impaired, due to refractive errors, can be used to assess the level of development of eye care services in a country.

Vision testing in children is the process of detecting vision problems, and is undertaken to improve prognosis and reduce disability. The word 'screening' has a very precise meaning in public health<sup>1</sup> and there are clearly defined criteria which should apply before any screening programme is established. (\*When considering the detection of refractive errors and other causes of visual impairment in older children, the term 'screening' does not really apply – 'vision testing' is perhaps a better term).

### Assessment of Need

There are few data available on the prevalence and types of refractive errors in children in developing countries, but in the USA the prevalence of vision problems is estimated to be 5–10%, while the prevalence of amblyopia is 1–5% in children.<sup>2</sup> In a study in India, 5.1% of children in schools had a visual acuity of < 6/12 in the better eye.<sup>3</sup> In Botswana, a survey of children in schools and in the community showed that 1.5% of children aged 5–15 years had a visual acuity of <6/18 in the better eye due to refractive errors, 78% of whom had a refractive error of less than +/- 2.00D (diopetre sphere) spherical equivalent.<sup>4</sup> At least 2000 children / million population have refractive errors greater than -1.00D in both eyes. These are the children who should be the focus of attention in any school vision testing programme.



Vision testing of children in Pakistan

Photo: Murray McGavin

Different age groups of children have different problems and needs (Figure 1):

### Planning a Vision Testing Programme for Children

There are several questions which need to be addressed and answered when planning a vision testing programme for children. The most important is to decide the aim of the programme. Others include:

- At what age will children be tested?
- Where will vision testing be done?
- What method of visual acuity measurement will be used?

Fig. 1: Age Groups and Specific Needs

Age group	Specific needs
Pre-school age <6 years	<ul style="list-style-type: none"> <li>• Significant refractive errors are uncommon</li> <li>• Undetected and untreated refractive errors, eye disease and strabismus can lead to amblyopia</li> </ul>
Early school age 6–11 years	<ul style="list-style-type: none"> <li>• Age at which myopia starts to develop</li> <li>• Undetected refractive errors which developed at a younger age are still present</li> <li>• Treatment of amblyopia is probably too late</li> </ul>
Late school age 12 years & older	<ul style="list-style-type: none"> <li>• Myopia progresses and then stabilises<sup>5</sup></li> <li>• Undetected refractive errors which developed at a younger age are still present</li> </ul>

- What level of visual acuity will be used to identify children who need further examination/refraction?
- Who will measure the vision?
- Where will the follow up examinations and refraction be performed?
- Who will do this?
- How will services be provided for children who need them?
- How will the programme be monitored and evaluated? (see Figure 2).

### Aim of Vision Testing Programme

Before establishing a vision testing programme, it is important to consider the aim of the programme. If the aim is to detect and treat conditions that may lead to amblyopia (i.e., refractive errors, eye disease causing visual impairment, and strabismus) the programme must focus on pre-school age children. This approach presents considerable challenges, as examining young children and measuring their visual acuity or refractive errors is difficult, particularly in a non-clinical setting. Another difficulty is that in many countries there is no readily identifiable ‘catchment’ population of pre-school age children, which adds logistical difficulties. For all these reasons, formal pre-school screening programmes are not established in many industrialised countries.

If the aim is to detect and treat ‘significant’ uncorrected refractive errors and eye conditions causing visual impairment, older children can be targeted. Again, consideration has to be given to the age at testing – testing only 6–7 year olds in primary school will increase the proportion of children examined (as school attendance rates at this age are high in most countries), but will be too young to detect myopia of puberty. If vision testing is undertaken to detect myopia in 12–14 year olds, those with early



Follow-up of vision testing by refraction

Photo: Murray McGavin

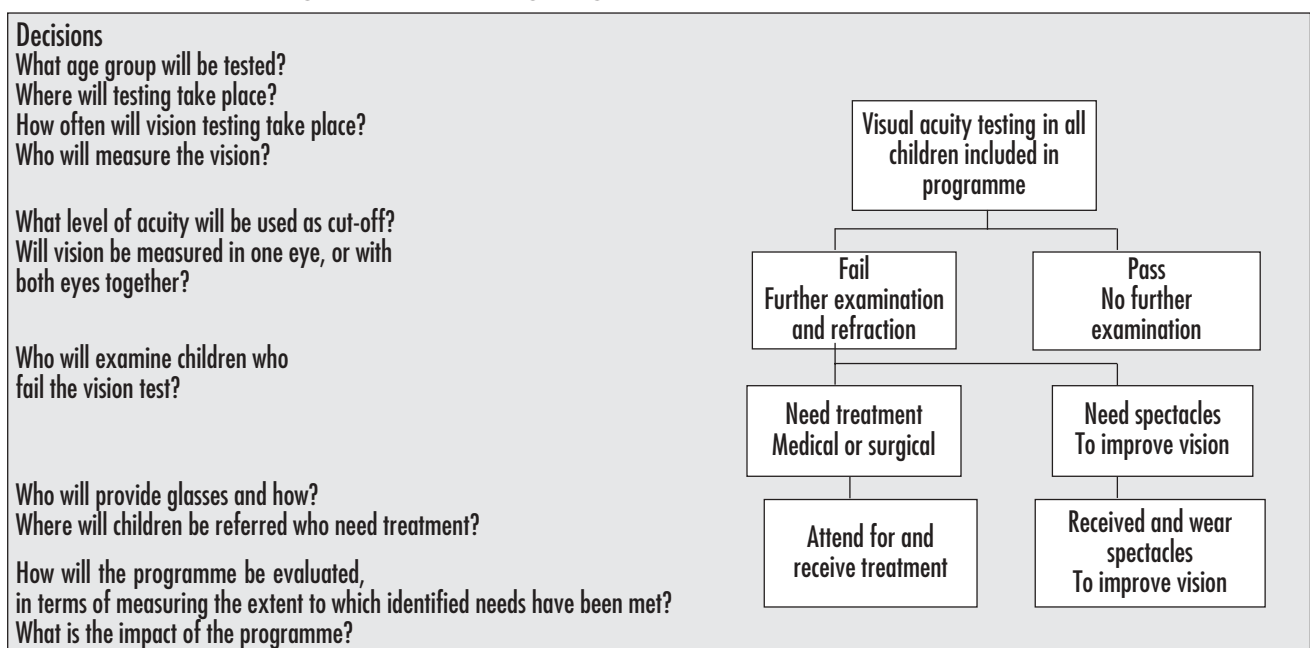
onset refractive errors will have many years of poor vision, and may have dropped out of school for this reason.

The frequency of vision testing needs to be linked to the availability of resources. If conditions are favourable, children should be screened once during the primary school years (6–11 years) and once during early adolescence (12–14 years). This is the ideal for developing countries. However, if resources are limited, it is best to start in early adolescence – because most children would have manifested their myopia by that time, children of this age readily comply with vision testing, and because more are likely to wear spectacles when prescribed.

### Testing Vision: How and Who?

The initial test of visual acuity identifies children who are ‘abnormal’ and who need to be refracted and examined in more detail. Decisions need to be made whether to measure vision in each eye separately, or

Fig. 2: Vision Testing Programmes: Decisions and Flow Chart



with both eyes open. The level of acuity that denotes ‘failure’ also has to be decided. If the level of acuity is too high (i.e., less than 6/9 in one or both eyes), a very high proportion of children will ‘fail’, many of whom would not need or benefit from glasses. If the level is set too low (i.e., <6/60 in the better eye), only those with severe visual impairment will be detected. In India, a cut off of < 6/9 in either eye is used to define abnormal vision. Children failing this test are referred to an ophthalmic assistant for refraction. In this programme more than 60% of the prescriptions were < 1.00D (dioptre sphere)<sup>6</sup> and it is not known how many of these children continue to use spectacles in the long term. To increase the cost effectiveness of a school vision testing programme, it is probably wise to use <6/12 in the better eye to determine ‘abnormal vision’. The visual cut off level is also dictated by the compliance of populations with spectacle use.

The method of vision testing needs to be valid (Figure 3). In other words, the test should identify those children who will benefit from treatment (i.e., spectacles). The test should not refer too many children who cannot benefit from treatment (false positives), as this will cause anxiety in the families and overload the available services. Also, the test should not miss children who need spectacles (false negatives).

The balance between sensitivity and specificity is important. If a programme uses a visual acuity cut off < 6/6 in either eye, the test would have a very high sensitivity, as all the ‘visually impaired’ would be identified by the test. However, there would be many false positives, and a large number of normal children would be referred for diagnostic work up.

If < 6/12 in the better eye is used as the cut off for normal vision, the sensitivity would be lower than if <6/6 was the cut off, as some children who may need spectacles would pass the vision test. The positive predictive value would be higher, indicating that most of the children referred would indeed be found to have refractive errors, with some having loss of vision from other causes.

Trained eye workers (i.e., ophthalmic paramedics, opticians or ophthalmologists) should not undertake the initial testing, as it is not a good use of their time. Whoever does the vision testing in schools needs to be trained. In India, school teachers have been identified for this purpose – in other programmes community volunteers have been used successfully. In India, preference is given to female teachers who wear spectacles themselves, as they have heightened awareness of the problems of refractive errors.<sup>5</sup> After one day’s training, the teachers are provided with a vision testing kit.

### Vision Testing in Schools

Once the training is complete, the vision testing can start. It is preferable to complete the screening during the period when children do not have any examinations. The procedure for testing should be explained – a big cut-out of an E can be shown to the child, and the directions of the limbs of the E explained. If the child already wears glasses, vision should be recorded with the spectacles. As children can memorise the Snellen chart quickly, a card with 4 E optotypes of the same size is preferable. Children should not stand too close together, as they also tend to ‘help’ each other!

Good lighting is important and testing can be done outdoors. The vision should be immediately recorded for each child, and a list made of all the children who fail vision testing, to ensure that all those who need further assessment are correctly referred.

### Examination and Refraction

All children who ‘fail’ the initial vision test must be examined and refracted, and the cause of their problem identified. This can either be done by ophthalmic staff who go to the school and set up a temporary dark room, or by referring children to a nearby eye department or optician. Mechanisms for refraction and examination must be set up before

embarking on vision testing, as the programme will fail if children are tested and there is no referral system. Parents should be involved so they can participate in the process.

### Service Provision

Services should be provided for all children who need spectacles or eye treatment. Good quality, low cost spectacles should be available for the parents to buy. Many families are happy to purchase a pair of spectacles if they consider it to be important. In India, a contract is drawn up with a local optician who is

Fig 3. Validity of Screening Tests

		Need for Spectacles (‘Significant’ Refractive Error)	
		Present	Absent
Result of Vision Testing in School	Fail	A Children who need spectacles correctly identified (true positives)	B Normal children labelled as abnormal by test (false positives)
	Pass	C Children who need spectacles but pass the vision tests (false negatives)	D Normal children correctly identified (true negatives)
Sensitivity = A / A+C Specificity = D / B+D		Positive predictive value = A / A+B Negative predictive value = D / C+D	

willing to provide spectacles at a competitive price. The students do not pay anything to the optician, as the costs are covered by the programme. In some instances arrangements are also made for the optician to deliver spectacles to the schools.

### Follow-up of Children

Once a child has been diagnosed, he/she should be re-examined at intervals of 1–2 years by the optometrist / ophthalmologist. This is particularly important for myopic children, as their myopia might progress.

### Monitoring, Evaluation and Impact

School vision testing programmes do not end with the provision of spectacles, as it is important to evaluate the benefit of the programme. This can be done by determining the proportion of children screened who needed spectacles, the number prescribed glasses who actually wear them, and the number of children whose vision has been improved as a result of the programme. Evaluating the impact of the programme is more difficult, as this would involve making an assessment of the wider educational, social and economic benefits resulting from improved vision in school children. The impact will be low if only mild refractive errors are corrected.<sup>7</sup>

Vision testing programmes in schools not only help the children but also help communities, as awareness about good vision is increased amongst teachers and parents. Teachers and parents should be taught to look for symptoms and signs which indicate refractive errors. They can observe if children hold books unusually close to their eyes, sit close to the TV, rub

their eyes frequently, or twist or tilt their heads to favour one eye.

### Summary

In conclusion, school vision testing programmes are simple to conduct, need minimal resources, greatly benefit children with significant refractive errors, and have an impact on concerned communities by increasing their knowledge of vision disorders and how to manage them. However, they need careful planning and resourcing. More information is required from different populations as to what level of visual acuity should be considered as 'abnormal'. This will result in appropriate identification of children who will wear and benefit from spectacles.

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# Case Finding for Refractive Errors: Assessment of Refractive Error and Visual Impairment in Children

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The World Health Organization informal planning meeting, in July 2000, clearly indicated that detailed comparisons of refractive error prevalence across study reports are generally not possible because of different measurement methods and definitions.<sup>1</sup> Further, because most studies are carried out using samples of unknown representativeness, interpretation of the findings in a population-based context has problems.

## RESC Studies

An exception to this difficulty is a series of population-based surveys of refractive error and associated visual impairment in school-age children, conducted in five different geographic regions using a common protocol – the Refractive Error Survey in Children (RESC).<sup>2</sup> These RESC surveys, which began in 1998, were carried out in a rural district in eastern Nepal;<sup>3</sup> a rural county outside of Beijing, China;<sup>4</sup> an urban area of Santiago, Chile;<sup>5</sup> a rural district near Hyderabad in southern India;<sup>6</sup> and an urban area of New Delhi in northern India.<sup>7</sup> A sixth survey is currently being carried out in Durban, South Africa. Others are planned.

In each survey, population-based samples of approximately 5000 children, aged 5 to 15 years, were obtained through cluster sampling. Clusters were defined in rural areas using village boundaries, while in urban areas community blocks or wards were used. The sample size was designed to obtain reasonably accurate prevalence estimates at age- and sex-specific levels.

## Clinical Measurements

Enumeration of children within the randomly selected clusters in each study was followed by clinical



Better vision with spectacles for this child in Uganda

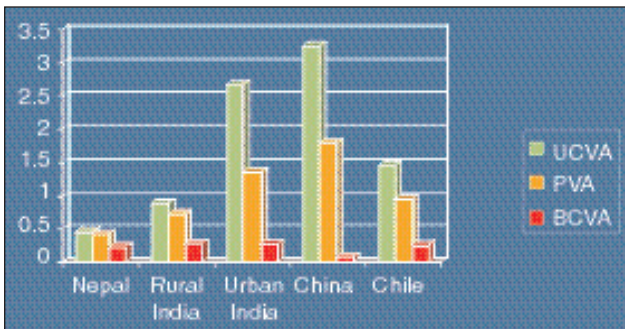
Photo: Murray McGavin

examination at one or more sites within the community. The examination included measurement of distance visual acuity using an illuminated LogMAR 'E' chart, near and distant, ocular motility evaluation with a cover/uncover test, cycloplegic dilatation with cyclopentolate, streak retinoscopy, autorefraction with a handheld Retinomax K-Plus, subjective refraction for those with unaided visual impairment, and slit – lamp and direct ophthalmoscope examination of the lens, vitreous, and fundus. A principal cause of visual impairment was recorded by the examining ophthalmologist for each eye with visual acuity of 6/12 or worse.

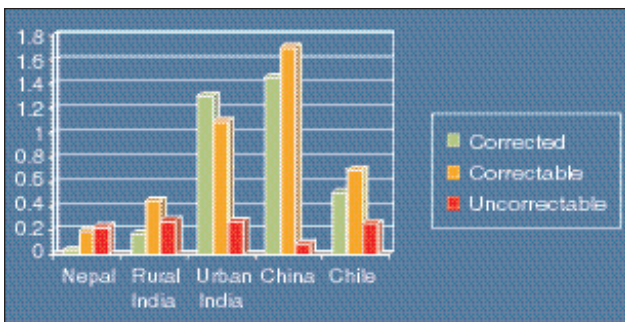
## Comparative Findings

Uncorrected visual acuity < 6/18 in the better eye ranged from 0.46% to 3.25% (Figure 1). With presenting vision – aided vision for those wearing

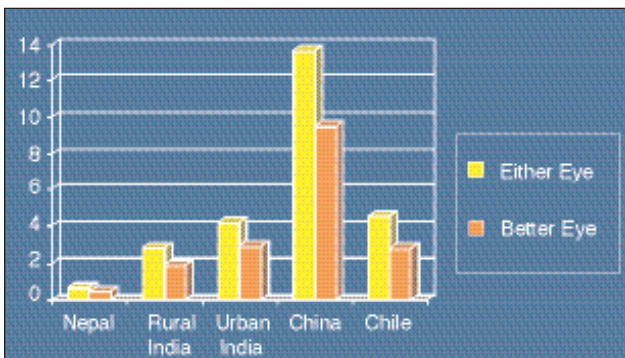
glasses – the prevalence of visual acuity < 6/18 in the better eye ranged from 0.42% in Nepal to 1.79% in China. With best corrected visual acuity, visual impairment was substantially reduced, ranging from 0.09% in China to 0.28% in rural India. The difference between presenting and uncorrected vision reflects the amount of refractive error that is already corrected, while the difference between presenting and best corrected vision indicates the extent to which uncorrected refractive error remains as a vision disabling problem. The prevalence of visual impairment with best refractive correction represents the degree of



**Fig. 1: Percentage prevalence of visual acuity < 6/18 in the better eye.**  
 UCVA: uncorrected visual acuity  
 PVA: presenting visual acuity  
 BCVA: best corrected visual acuity



**Fig. 2: Percentage prevalence of visual impairment < 6/18 in the better eye.** Corrected: already corrected visual impairment. Correctable: uncorrected, but correctable visual impairment. Uncorrectable: uncorrectable visual impairment.



**Fig. 3: Percentage prevalence of myopia: -1.00 spherical equivalent dioptres in either eye (worse eye) and better eye as measured with cycloplegic autorefraction.**



Recording visual acuity in Zanzibar

Photo: Murray McGavin

vision loss attributable to causes other than refractive error.

Although some of the refractive error underlying clinically significant visual impairment was found to have been already corrected with spectacles, an essentially equal amount of *correctable* refractive error remained uncorrected (Figure 2). This was the case in all five study areas, which were generally representative of lower and lower middle class populations in each country.

Refractive error in this age group was usually due to myopia with a relatively high prevalence among Chinese children (Figure 3). Although the relationship between uncorrected visual acuity and refractive error was not a precise one, among those with a relatively high prevalence of visual impairment, correspondingly high amounts of refractive error were found, as expected. The prevalence of hyperopia (hypermetropia: + 3.00 spherical equivalent dioptres or more in either eye) was found to be particularly high in Chile, 5.55%, and was accompanied by comparatively high levels of astigmatism as well (data not shown). Further information regarding the age- and sex-specific prevalence of both myopia and hyperopia is available in the original reports.<sup>2-7</sup>

## Conclusion

These comparative studies illustrate that the prevalence of myopia and hyperopia varies considerably across geographic regions. They also illustrate that visual impairment, which in this age group is almost entirely because of correctable refractive error, will vary in a corresponding fashion. Unfortunately, it appears that approximately half of the visual impairment associated with easily corrected refractive error remains uncorrected – at least among school-age children in lower and lower middle class populations. To the extent that these data represent children across different geographic and ethnic origins, as well as different cultural settings, reduced vision because of uncorrected refractive error is an important public health problem. Cost-effective

strategies are needed to eliminate uncorrected refractive error as a cause of disabling visual impairment, particularly during the formative years of children.

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# Case Finding in the Clinic: Refractive Errors

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The detection of refractive errors includes effective screening programmes in the school or community. However, the lack of human and other resources often prevent such programmes from occurring. Therefore, patients with many conditions, both refractive and non-refractive, present at clinics. The separation of these patients into refractive and non-refractive conditions is important in the good organisation of eye care clinics, as members of the eye clinic team can then carry out their different duties more effectively.

## General Considerations

Refractive error can be detected through the routine examination of patients who present to clinics, or through vision screening of the population at large.<sup>1</sup> An added component is the screening of patients in the clinic setting and combining this with the eye examination. This process will thus incorporate a case history, visual acuity, pinhole visual acuity, retinoscopy and a subjective examination.

Complaints of frontal headaches, poor concentration in school, inappropriate viewing distances, presence of tropias (eye-turns), tilting of the head (high cylinders), and 'squinting'/peering are indicators of refractive error. The pinhole occluder assists in determining the best visual acuity possible with a refractive correction. History combined with visual acuity tests and visual acuity through the pinhole, should enable the clinician to determine if refractive error is the cause of the patient's problem.<sup>2</sup>

Retinoscopy is an effective tool in determining the presence of refractive error in adults. Retinoscopy with cycloplegia is the most appropriate method of determining refractive error in children, given the accommodative status of children.<sup>3</sup>

A subjective refraction should include a binocular balancing technique and a full eye examination to detect other ocular abnormalities.

## Detecting Refractive Cases

### *Patients referred from a screening programme*

If the vision screening programme is known to have been established through proper protocols and training of staff, then the patients should be accepted in the clinic on the basis of the preliminary findings and a full refractive examination conducted. However, many screening programmes are incomplete, only using visual acuities and not a pinhole or +2.00D lens to detect latent hyperopia (hypermetropia). Such patients should be managed in a similar way to the self-presenting patients.

### *Patients not screened/self-presenting*

#### *Primary Level*

##### *Adults*

All patients should be tested using a Snellen acuity test (E Chart) at distance. Those with <6/6 vision should then be further tested with a pinhole test. Should the vision improve to 6/6 then the patient is classified as having a refractive error. Those patients with no improvement to 6/6 with a pinhole, are classified as non-refractive and referred to a secondary level for a full eye examination.

## Patients with a Refractive Error

### *1. Adults over 45 years of age*

The Refractive Error Working Group (REWG)<sup>1</sup> recommends that patients with a distance acuity of 6/18 or better (binocularly) should be provided with reading glasses for near. Patients with a visual acuity less than 6/18 should be referred to the secondary level for a refraction.

Patients with specific occupational demands may also need to be referred to the secondary level for a full eye examination.

### *2. Adults less than 45 years of age*

These patients will fall into the early presbyope or pre-presbyope category.

Should there be no occupational demands, patients with 6/18 or better (binocularly) need not be referred for a refraction while those with occupational demands should be referred to the secondary level for a full eye examination. Patients with 6/18 and better but with

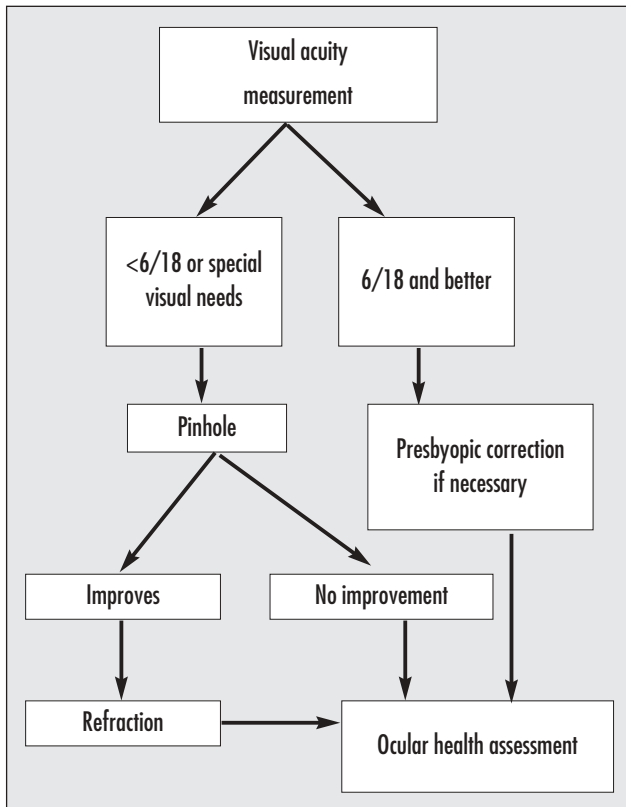


Fig. 1: Screening Adults in an Eye Clinic

near occupational visual demands should be dispensed presbyopic glasses ('readers').

### 3. Children

The REWG recommends that children be referred for refraction should they have a binocular visual acuity less than 6/12.<sup>3</sup> They should be referred to the secondary level for a full eye examination (including a cycloplegic refraction).

#### Secondary Level

Many patients present directly to the secondary level clinics, a consequence of which is an unnecessary increase in patient numbers.

Ancillary personnel (clinic assistants) should screen patients and determine the appropriate management – prior to seeing the Eye Care Practitioner (ECP) – utilising:

- Snellen acuity (E Chart).
- Pinhole test for those with <6/6.
- History – to determine age and symptoms.
- Visual acuity with a +2.00 D lens for children.

### Who is Referred for Refraction?

#### 1. Adults

- All patients failing the Snellen acuity test, improving to 6/6 with the pinhole test but with less than 6/18 binocularly (Figure 1).

- Patients complaining of headaches and with decreased visual acuity that is improved with a pinhole.
- Patients with occupational and special needs experiencing better visual acuity with the pinhole.
- Patients who are presbyopic.

#### 2. Children

- All children failing the Snellen test (<6/12 binocularly) (Figure 2) but improving with the pinhole test.
- Children with better than 6/12 vision but with no blurring of vision with a +2.00D lens.
- Children who present with symptoms consistent with refractive error.
- Children with tropias.

### Screening: False Referrals

Given the percentage of false referrals, children referred for ocular disease evaluation should be referred from the ECP for refraction should no ocular disease be detected.

### Malingers

Malingering could indicate behavioural and other problems or just a desire to wear spectacles and be like parents or friends.

Children failing the Snellen test and showing no improvement in visual acuity could, in fact, be malingers. Retinoscopy, with cycloplegia, is the best method to determine if a refractive condition exists.

The REWG recommends that children be considered myopic or hyperopic based on the following criteria:<sup>3</sup>

- Myopia:  $\leq -0.50D$
- Hyperopia:  $\geq +2.00D$

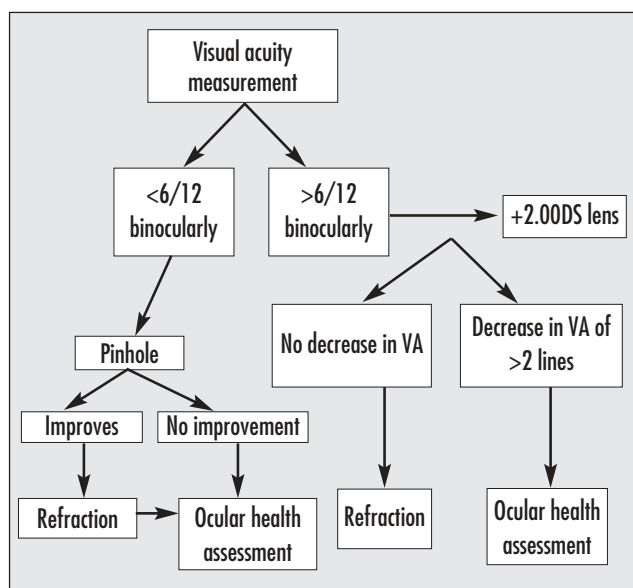


Fig. 2: Screening Children in an Eye Clinic

Tests for malingering may also use the following techniques:

- Put plano lenses into the trial frame and observe any improvement.
- Move the child closer to the chart and then take visual acuity. No improvement indicates malingering.

### **General Comments**

Children with binocular vision of 6/12 or better, with a visual acuity difference between the two eyes of more than two lines on the chart, should be referred for a refraction as amblyopia is a consideration.

If patient numbers are low, the screening protocol could be applied for all patients attending the hospital or clinic, not just the eye clinic patients.

### **Conclusion**

There is great variation in the availability of resources from region to region and country to country. Should the appropriate resources exist then consideration should be given to the 'lowering' of the referral criteria.

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# Guidelines for Setting Up a Child Based Low Vision Programme for Children

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## Introduction

Blindness and low vision are major causes of morbidity and have profound effects on the quality of life for many people. They bar the mobility and economic well-being of individuals, as well as their families. Childhood blindness (CBL) is one of the challenges faced by the world generally and developing countries in particular. In developed countries, certain mechanisms for normal schooling and socio-economic rehabilitation of visually impaired children exist. However, in developing countries due to scarce resources and traditional taboos, these children are rarely able to attend 'normal' educational institutions. Vision 2020: The Right to Sight, has recognised CBL and low vision and refraction as important strategic themes for the control of avoidable blindness.

## Clinical Definition

A person with low vision is one who has impairment of visual function even after treatment and/or standard refractive correction, and has an acuity of less than 6/18 to light perception or a visual field less than ten degrees from the point of fixation, but who uses (or is potentially able to use) vision for the planning and execution of a task.<sup>1</sup>

## Functional Definition

In 1989, Anne Corn defined low vision as 'a level of vision that, with standard correction, hinders an individual in the planning and/or execution of a task,



*Using a stand magnifier for near vision*

*Photo: Lynne Ager*

but which permits enhancement of the functional vision through the use of optical or non-optical devices, environmental modifications and/or techniques'. Natalie Barraga, in 1983, designated children with low vision as those who have limitations in distance, but are able to see objects and materials within a few inches, or at a maximum of a few feet away.

There is now an increasing acceptance of a behavioural function, rather than a medical basis, for low vision. However, children in developing countries are rarely encouraged to develop the use of residual vision and its existence is often ignored by medical and education staff. The challenge for us is to recognise ways to enable partially sighted children to benefit from their residual vision through the provision of appropriate services, materials and devices.

This paper attempts to provide some guidelines on how a child based low vision programme could be set up in a developing country.

## Ten Logical Steps to Developing a Child Based Low Vision Programme

### *Step 1: Establish a Need*

The need can be established using direct or anecdotal evidence. This may be in the form of census surveys that give the proportion of children under 15 years, national prevalence of blindness surveys, surveys of

schools for the blind, blind registry's, and regional estimates of prevalence of childhood blindness. The mean global prevalence of childhood blindness/severe visual impairment (BI/SVI) is 0.75/1000 and the prevalence of low vision is about twice that number.<sup>2</sup> While establishing a need at national level, it is also helpful to determine the magnitude at the provincial and district levels, where appropriate.

### ***Step 2: Situation Analysis of Available Infrastructure, Human Resources and Technology***

The next step in the sequence of planning is to conduct a situation analysis of the available infrastructure (eye care services, education institutions, social welfare services, and organisations for the blind). Human resources available for service delivery to the visually impaired at tertiary level (ophthalmologists, optometrists, special education/resource/itinerant teachers and orthoptists), at secondary level (ophthalmic medical assistants, nurses, refractionists, teachers, orientation and mobility instructors) and at primary level (community based rehabilitation workers, community health workers and social workers) and appropriate technology opportunities available, i.e., current level of optical services and its capacity to produce assorted low vision devices. The situation analysis should also identify what current legislation/laws ensure the rights of disabled persons and how they can be utilised effectively.

The situation analysis will identify the most suitable cadres on whom the service can be based (at the tertiary, secondary and primary levels). The review of the infrastructure will determine where the services will be based, to ensure maximum utilisation. An analysis of the technology available will help in determining what can be produced/procured locally and what will be needed from external sources.

### ***Step 3: Gap Analysis of Available Resources***

As a precursor to a low vision programme, a concept will have to be developed that outlines what is available and what needs to be achieved over a certain period of time, and the difference between these would be the gap analysis. This could be in the form of training that needs to be imparted to existing cadres to be able to perform a low vision assessment,<sup>3</sup> prescribe low vision devices (LVDs) or manufacture low cost LVDs.<sup>4,5</sup> It may also involve determining means and ways to utilise existing infrastructure, e.g., space in an eye department for a low vision clinic optimally.

### ***Step 4: Develop a Plan for Low Vision with Short, Medium and Long Term***

#### **Objectives**

The situation analysis and the gap analysis together will form the basis for development of a plan for low vision services for children. Usually, this forms part of a more comprehensive low vision programme. It is useful to define short, medium and long term

objectives. Examples of short term objectives could be training of core cadres in low vision, awareness workshops for eye care professionals, adding on a low vision component on existing training programmes, e.g., paramedics and teachers, and standardising curriculae to incorporate low vision. Medium term objectives may include establishment of low vision clinics, networking of service providers, and development/enhancement of the local capacity to produce LVDs. In the long term, the low vision concept and component should be fully integrated into a national comprehensive eye care programme with an incremental increase in the quality and coverage of service.

### ***Step 5: Identify and Mobilise Resources***

Even though the main emphasis on developing a low vision programme remains the optimal and effective utilisation of existing resources, nevertheless, some external support will still be required in the form of training of national focal/resource persons in low vision and setting up of low vision clinics (supply of equipment). The different components of the plan (short, medium and long term) should be costed and funding sought from the government, non-governmental organisations, community based and service organisations and commercial enterprises willing to support programmes for disabled persons.

### ***Step 6: Pilot the Programme in a Defined Setting or Area***

As in most new programmes, it is advantageous to first pilot the plan in a defined setting or area to test the concepts proposed and identify deficiencies. The piloting phase could conceivably be done by identifying a district that has a secondary level eye unit, availability of optical services and an educational institution willing to participate in this programme. Access to a tertiary eye department and existence of an on-going community based rehabilitation programme in the area are definite added advantages.

### ***Step 7: Develop Local Expertise for Production of Assessment Materials and LVDs***

Simple optical and non-optical low vision devices and assessment materials can be produced in most countries where basic optical services exist. The assessment materials can be developed using a desk top computer with a laser printer. A semi-skilled technician with basic optical knowledge can be trained in a short time to produce low vision devices. Most of the materials involved in the production of low vision devices are usually available locally and may include PVC pipes and optical lenses. The issue of non-availability of optical lenses in higher power and aberrations associated with these lenses can be overcome by combining 2 or 3 low powered lenses to produce a higher power system.

### ***Step 8: Network with Other Service Providers of Visually Impaired***

The role of low vision service as a bridge between medical, educational and rehabilitative services has been recognised. The low vision centre in the district can act as a referral point for the child to access other services that may be required, e.g., orientation and mobility training, early intervention, and peer support groups. One way in which this could be brought about is to hold networking meetings between the different service providers and develop a consensus on the modality for detection of the visually impaired child in the community, referral to a low vision clinic for assessment and prescription of LVDs, appropriate placement in school, access to statutory benefits and elimination of blocks to eye care.

### ***Step 9: Replicate the Pilot Model by Integration into the National Vision 2020 Programme***

The lessons learned from the piloting phase can then be employed to develop a larger programme within the framework of a national Vision 2020 programme. This will ensure its lateral integration with other eye care related activities, remove the need to set up a vertical programme, and promote its long term sustainability.

### ***Step 10: Maintain the Dynamic Character of the Programme and Increase Coverage***

The low vision programme, thus developed as part of a national comprehensive eye care plan should be dynamic in character with an ability to absorb changes in technology, move towards sustainability and have included within it a mechanism for reporting, monitoring and evaluation. The goal should be to increase the coverage of the service and continually improve its quality.

## **Conclusion**

Most specialties in ophthalmology are costly to develop and require specially trained people and sophisticated equipment. Low vision as a specialty is one area that can easily be initiated in any ophthalmic,

educational or optometric set-up with a minimum of investment and training. Most of the devices used for assessment can be produced locally using indigenously available materials and appropriate technology. The use of simple magnifiers can help children pursue education in normal stream schools and improve their quality.

Each country can identify its own relevant existing human resources and train them in a short period of time to provide low vision care in a school, hospital or clinic setting. Standard manuals on production of inexpensive low vision devices can be utilised to make these devices. As experience is gained, and with some input from external sources, a cost effective and sustainable low vision service can be developed. It would be preferable to plan the development of any such service so that it is capable of fitting in the ongoing national health, educational and social welfare programmes. This will not only ensure its sustainability and cost containment but also its early acceptability and implementation.

In developing countries, it is neither practical nor economical to establish separate low vision programmes for adults and children. Often it is more realistic to develop low vision services for both children and adults. Furthermore, where specialised tertiary centres exist (e.g., tertiary teaching eye departments with established specialty clinics, institutes of child health), the possibility of establishing 'Early Intervention' clinics/centres for very young children and infants with severe impairment should be explored.

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# Optical Services for Visually Impaired Children

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An estimated 1 in 250 children are visually impaired as a result of eye disease. Some of these children have nearly normal vision, some are totally blind, but the majority fall into a broad range between these two points. Children are said to have 'low vision' or 'partial sight' when they have: (a) a corrected visual acuity in the better eye of <math><6/18</math> to 'perception of light' (or a visual field of less than 10 degrees); and (b) the ability to use their residual vision to orientate themselves or to perform tasks.<sup>1</sup> They are identified at eye clinics, school screening programmes, community based rehabilitation (CBR) programmes, or special schools for the visually impaired.

The education, employment prospects, independence and quality of life of a child with low vision can all be improved by enhancing vision. Optical devices



*Accurate refraction and spectacle correction help many children with low vision*

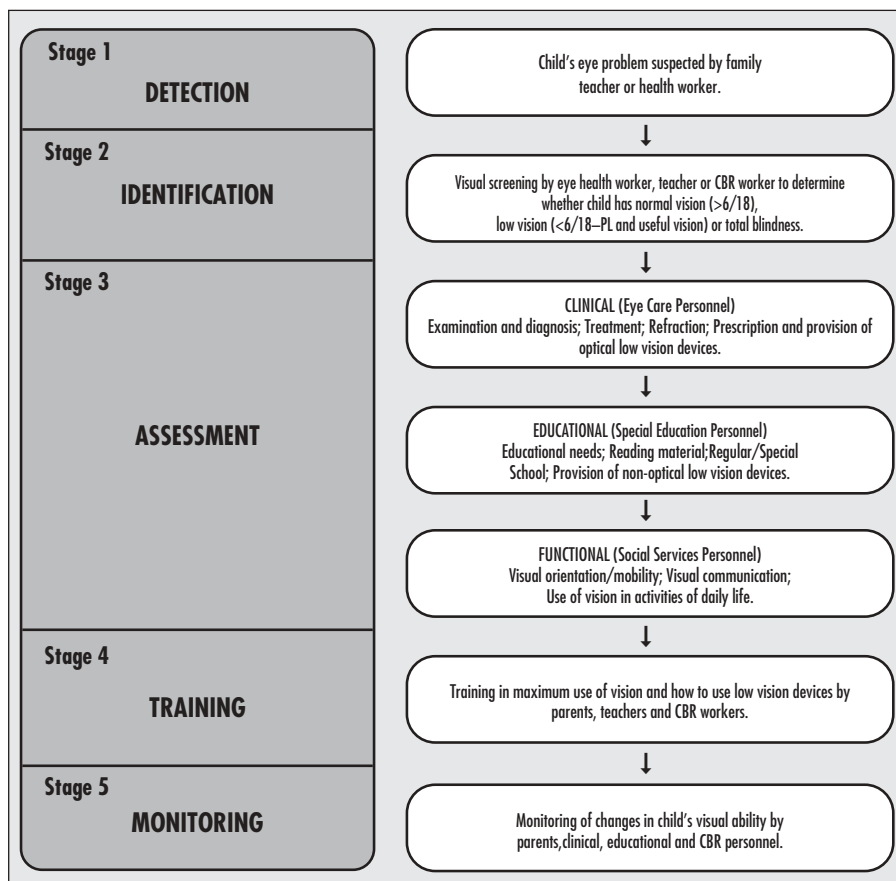
*Photo: Murray McGavin*

(spectacles, magnifiers and telescopes) play a key role in achieving this. Studies carried out in East Africa,<sup>2</sup> South America<sup>3</sup> and West Africa<sup>4</sup> indicate that approximately half of children who have low vision show an improvement in distance and/or near visual acuity, with the help of spectacles, a magnifier or both. The majority of magnifiers are prescribed for children who have a visual acuity in the better eye of <math><6/60</math> to 1/60.<sup>3,4</sup>

## The Role of Optical Services in the Management of Children with Low Vision

The management of children with low vision requires co-operation between the child, his/her family and eye care educational and social personnel. There are five stages in the management of children with low vision (Figure 1). Eye care personnel are primarily involved in the assessment and monitoring stages, which include: a) visual acuity measurement (distance and near); b) eye examination, diagnosis and prognosis; c) surgical and/or medical treatment and, d) the provision of optical services.

**Fig.1: Stages in the Management of Children with Low Vision**



Sight is a key source of stimulus during a child's development, and so children with low vision should be motivated to make the maximum use of their residual vision. This can be done using both non-optical and optical methods.

### Enhancing Vision using Non-optical Methods

- Move CLOSER, e.g., use an angled reading desk
- Use COLOUR to show objects more clearly
- Use CONTRAST, e.g., eat white rice off a coloured plate
- Pay attention to LIGHTING, e.g., sit near a window in class
- Make objects LARGER, e.g., write with larger letters
- Use a LINE-GUIDE, such as a ruler, when reading and writing.

### Enhancing Vision using Optical Devices

Optical devices play a key role in enhancing vision and reducing visual disability in children with low vision. They include: standard prescription spectacles; optical low vision devices for distance vision; and optical low vision devices for near vision.

(a) *Standard prescription spectacles:* It is important to ensure that children with low vision are refracted and provided with any spectacles they require. Work in West Africa indicates that at least 30% of children with low vision need spectacles.<sup>4</sup> Refraction should always be carried out before a magnification assessment.

(b) *Optical low vision devices for distance vision:* Distance vision magnification requires a telescopic lens system. Telescopes are expensive and have limited applications. It is often more practical for a child to sit near the front of class to see the backboard than to use a telescope.

(c) *Optical low vision devices for near vision:* An optical low vision device for near vision uses one or more lenses placed between the eye and an object, to alter the retinal image size of the object. This makes the object larger and easier to see. The minimum dioptric power of a device used in this way is +4.00D. These devices are inexpensive and have a wide range of applications. They play a vital role in giving children with low vision access to print and illustrations in standard textbooks.

### Prescribing Magnifiers for Near Vision

The *power* of magnifier prescribed for a child is determined by the child's visual requirements, recorded near visual acuity and measured working distance. They are prescribed, starting with low power magnifiers and then progressing to higher powers. The higher the power, the smaller the area of visual field seen through the magnifier. More words in a sentence can be viewed through a +10D magnifier than through a +20D magnifier. The power of the magnifier



*Aphakic spectacle corrections after congenital cataract surgery for two Romanian children*

*Photo: Clare Gilbert*

prescribed should be the maximum power which enables the child to perform the task required, but not above requirements, so that maximum visual field is maintained. Moving the eye closer to the lens of a hand-held or stand magnifier also increases the field of view. In West Africa, 71% of magnifiers prescribed were low power magnifiers (under +25D).<sup>4</sup> These were prescribed more frequently for those with a visual acuity of 3/60 or better. High power magnifiers (over +25D) were prescribed in 29% of cases, and were mainly prescribed for those with a visual acuity of less than 3/60.

To determine the appropriate *type* of magnifier, it is important to assess the child's personality, co-ordination, motivation and task aims. The same magnification can be provided using different mounting systems and working distances. Optical devices for near vision include: hand-held magnifiers (illuminated or non-illuminated); stand magnifiers (illuminated or non-illuminated); spectacle mounted magnifiers (e.g., high plus spectacle lenses, hyperocular lenses); and spectacle mounted telescopic units. The most widely available optical low vision devices for near vision are non-illuminated hand-held magnifiers, non-illuminated stand magnifiers, and high plus spectacle lenses. Advantages and disadvantages of these three types of magnifier are indicated in Table 1.

There are many benefits in providing magnifiers to children with low vision. The magnifiers encourage children to use their low vision to the full, thereby increasing visual stimulus and helping the children's development. The magnifiers promote literacy by increasing access to printed material for educational purposes and private reading. It is also more cost effective to provide children with optical devices enabling them to use standard books, than to provide large print books which are expensive and heavy to carry.

There are some limitations in providing magnifiers. Using a magnifier may make a child's visual disability more noticeable, causing the child to feel different from other children. The human and financial resources available to provide the magnifiers may be limited. The child needs to be taught carefully how to use the magnifier, as the restricted field of view can

**Table 1: Practical Differences Between Magnifiers**

	<b>Hand-Held Magnifiers</b>	<b>Stand Magnifiers</b>	<b>High Plus Spectacle Lenses</b>
<b>Uses</b>	<ul style="list-style-type: none"> <li>• reading</li> <li>• looking at pictures</li> <li>• writing</li> <li>• identifying money</li> <li>• inspecting small objects</li> </ul>	<ul style="list-style-type: none"> <li>• reading</li> <li>• looking at pictures</li> </ul>	<ul style="list-style-type: none"> <li>• reading</li> <li>• writing</li> <li>• looking at pictures</li> <li>• close range</li> </ul>
<b>Advantages</b>	<ul style="list-style-type: none"> <li>• easy to carry around</li> <li>• available from low to medium power</li> <li>• inexpensive to make</li> <li>• can be used at any position or angle</li> </ul>	<ul style="list-style-type: none"> <li>• has a fixed, stable working distance</li> <li>• easy to use</li> <li>• available in low, medium, or high power</li> </ul>	<ul style="list-style-type: none"> <li>• range of magnification</li> <li>• both hands free</li> <li>• readily available</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>• difficult to keep appropriate distance</li> <li>• one hand occupied</li> <li>• difficult to hold steady</li> </ul>	<ul style="list-style-type: none"> <li>• one hand occupied</li> <li>• not useful for writing</li> <li>• bulky to carry around</li> <li>• need flat working surface</li> </ul>	<ul style="list-style-type: none"> <li>• exact reading distance important</li> <li>• heavy to wear</li> </ul>

prevent a child from perceiving the overall pattern of words, or sentences, on a page.

### Supply of Magnifiers

Low power magnifiers can be made easily, using locally available materials. An optical workshop in Nairobi, Kenya developed a design using mounts made from plastic drain-pipe tubing. These are now used world-wide, as they are inexpensive (approx. \$6 each) and robust. Hand-held and stand magnifiers can be made in a range of powers, from +8D to +28D. Instructions for making these are available from Christoffel Blindenmission, Nibelungenstrasse 124, D-64625 Bensheim, Germany. Higher power magnifiers can be imported from Combined Optical Industries Limited (COIL), UK or Eschenbach, Germany. These are made from lightweight, plastic aspheric lenses, and cost between \$6 (low power hand-held magnifier) and \$34 (high power stand magnifier). They range in power from +8D to +76D.

### Case Studies

In West Africa, 291 students with low vision were identified at eye clinics, special schools for the visually impaired, integration programmes and CBR programmes during 1995/6. All received an initial visual assessment, including distance and near visual acuity measurement, refraction, magnification assessment and a quantitative measure of their level of functional vision. The functional vision tests included orientation, activities of daily life, ability to recognise pictures and reading speed. A follow-up assessment was received by 139 students. At first assessment, 44%

(128/291) of the students showed an increase in distance or near visual acuity with an optical device. Potential to read normal print (N10 or better), with or without the help of spectacles and/or a magnifier, was shown by 55% (159/291) of students. Those who benefited were provided with optical devices, and all the children with low vision received non-optical low vision devices and educational support. At follow-up assessment six months later, 63% (88/139) of students with low vision showed a further improvement in their distance visual acuity, near visual acuity and/or their functional vision. In special schools for the visually impaired in Ghana, 46% of students with low vision showed an improvement in reading and/or writing at their follow-up assessment.

These figures indicate that correctly prescribed optical devices can be of significant benefit to the child with low vision and, therefore, the provision of optical services should be an integral part of any low vision service.

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