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Integrating primary eye care into global child health policies

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ABSTRACT
Globally, approximately 75% of blind children live in low-income countries (LICs). Almost half of blindness and low vision in LICs is due to avoidable causes such as corneal scarring from measles infection, vitamin A deficiency disorders, use of harmful traditional eye remedies, ophthalmia neonatorum and cataract.

BACKGROUND

Avoidable visual impairment and blindness in children

Blindness and vision loss in childhood can have far reaching consequences, impacting psychomotor and cognitive development, educational attainment, employment, earning potential and well-being.[1 2] There are often negative social and financial consequences for the child's family as well.[1] Children who are blind are also more likely to die in childhood than a child with good vision, particularly if they live in low-income countries (LICs).[3] The prevalence of blindness varies from 12 to 15 per 10 000 in very LICs compared with per 3–4 per 10 000 in high-income countries.[2] Approximately 75% of blind children live in LICs. These figures do not include uncorrected refractive errors, principally shortsightedness, which affects an estimated 2 million children globally, the majority of whom are aged 10 years and above.

The causes of blindness in children also vary, reflecting socioeconomic development, cultural practices (eg, consanguinity), coverage of preventive measures (eg, measles immunisation) and access to appropriate eye care and optical services. Vitamin A supplementation (VAS) and measles immunisation programmes in LICs have reduced corneal scarring and visual impairment as a cause of avoidable blindness.[2] However, in sub-Saharan Africa almost half of all blindness and low vision in children remain due to preventable or treatable causes.[4] In LICs, the majority of blind children, excluding those with refractive errors, are either born blind or become blind by the age of 6 years, so children of this age group and their mothers are key targets for intervention.[5]

Global child eye health policy

VISION 2020 was launched in 1999 by the WHO and the International Agency for the Prevention of Blindness (IAPB) to eliminate avoidable blindness globally by 2020, including blindness in children.[6] In 2002, WHO identified 13 targets for child eye health, which included reducing the global blindness prevalence from 7 to 4/10 000 children, eliminating corneal scarring and ensuring access to tertiary eye care services for children with cataract. Ten 'key activities for healthy eyes in children' were also recommended for integration into primary maternal and child health services and inclusion in national prevention of blindness plans, emphasising the close relationship between general child health and eye health[7] (table 1). Although there has been some progress in terms of tertiary eye care for children, little attention has been paid to primary eye care (PEC).

Rubella immunisation has not been included in these 'activities' as policies vary between countries dependent on the local epidemiology and immunisation rates. Retinopathy of prematurity is a growing cause of avoidable blindness in low and middle-income countries (LMICs) but the focus of prevention and intervention is either at maternal services or tertiary level neonatal services therefore not at primary care level for children.

Global child health policy

In 1995, WHO and Unicef launched the Integrated Management of Childhood Illness (IMCI) to promote integrated services to reduce mortality and morbidity from key treatable and preventable diseases in countries with high under-five mortality rates. Care of newborns was added in 2003 as Integrated Management of Neonatal and Childhood Illnesses (IMNCI). Over 100 countries have adopted IMNCI to varying degrees. Although IMNCI includes ear conditions, eye conditions are not included, with the only mention of eye diseases being that 'children with measles may develop conjunctivitis, which should be treated with tetracycline eye ointment.' As a consequence, staff providing primary level services for children are not trained in eye care nor do they have the awareness and skills to prevent and manage eye conditions.[8]

ADDRESSING AVOIDABLE VISUAL LOSS AND BLINDNESS IN CHILDREN THROUGH PEC

The WHO 'ten key activities for healthy eyes in children' provide a clear blueprint for what needs to be addressed at primary care level. They address both prevention and active management of eye diseases in children and fall into three categories: health promotion (eg, breast feeding, face washing), ensuring high coverage of specific preventive measures (eg, VAS, measles immunisation) and the detection and referral of treatable eye conditions (eg, cataract, glaucoma). Some of these 'activities' are already part of child health programmes and IMCI, such as breast feeding, VAS and measles

Table 1 Ten key activities to promote healthy eyes in children

Control of conditions which can be associated with visual loss	
Vitamin A deficiency	1. Give vitamin A supplements to children routinely. 2. Give vitamin A supplements to mothers after delivery. 3. Promote breast feeding and good nutrition.
Measles	4. Give vitamin A supplements to children with measles or malnutrition. 5. Immunise children against measles.
Control of ocular conditions	
Conjunctivitis of the newborn	6. Clean the eyes of babies at delivery and apply antibiotic drops.
Trachoma	7. Keep children's faces clean.
Cataract/retinoblastoma/ocular abnormalities	8. Refer children with poor vision, white pupils or ocular abnormality to an eye worker.
Traditional eye remedies	9. Avoid the use of traditional eye medicines.
Trauma	10. Refer children with history of injury to an eye worker.

Table 2 WHO recommendations for vitamin A supplementation of children[34]

Target group	Infants 6–11 months	Children aged 12–59 months
Dose	100 000 IU (30 mg retinol equivalent)	200 000 IU (60 mg retinol equivalent)
Frequency	Once	Every 4–6 months
Route of administration/ preparation	Oral liquid, oil-based preparation of retinyl palmitate or retinyl acetate	
Settings	Populations where the prevalence of night blindness is 1% or higher in children 24–59 months of age or where the prevalence of vitamin A deficiency (serum retinol 0.70 µmol/L or lower) is 20% or higher in infants and children 6–59 months of age	

immunisation, although primary care workers may have no knowledge that they relate to eye health. Other 'activities' would require primary care workers to acquire new skills and basic equipment, for example, to assess the red reflex of newborns to detect cataracts. We will now discuss the evidence base and rationale for the activities recommended.

Vitamin A deficiency: prevention

Strategies to prevent vitamin A deficiency include VAS, nutrition education and breast feeding. Vitamin A (retinol) has multiple functions and is essential for epithelial integrity, immune competence, growth and retinal function. Retinol deficiency is called vitamin A deficiency disorders (VADD) to reflect the wide impact on multiple systems. Some ocular signs of VADD reflect chronic deficiency (night blindness, Bitot's spots) while other signs reflect acute deficiency (corneal ulceration, keratomalacia) which can lead to blindness. Six monthly VAS from 6 to 59 months of age is one of the recommendations of IMCI due to its impact on childhood morbidity and mortality.

Data from population-based surveys between 1991 and 2013 indicate that VADDs remain prevalent in LMICs, despite improvement in coverage of VAS.[4] One possible explanation for this apparent inconsistency is that six monthly high-dose vitamin A may not maintain adequate serum retinol levels between dosing, and more emphasis should be placed on dietary intake. There are few recent data on the prevalence of corneal ulceration or blindness due to VADD, but VAS has been shown to reduce the ocular signs of chronic deficiency. For example, a Cochrane review and meta-analysis of VAS reviewed mortality and morbidity data from 43 trials involving 215 633 children aged 6 months to 5 years. The review showed that VAS was associated with significant reductions in Bitot's spots (risk ratio (RR) 0.42; 95% CI 0.33 to 0.53) and night blindness (RR 0.32; 95% CI 0.21 to 0.50).[9] However, there was considerable heterogeneity with three trials showing no effect on VADD while another two reported a 69% reduction in xerophthalmia. The largest trial was based in India and enrolled 1 million children. In this trial, a subgroup analysis of approximately 2500 children in each arm of the trial showed that serum retinol levels were slightly higher in supplemented children and the prevalence of severe deficiency was half that of the control group. The prevalence of Bitot's spots was also considerably lower among supplemented children (1.4% vs 3.5%). Notably, this trial did not show as large an effect on child mortality as expected from previous trials (20%–30%), but suggested a reduction of 5%–15%.[10]

Given the impact on child mortality, the WHO recommends VAS of children aged 6 months to 5 years in countries where VADDs are a public health problem (table 2).

Population level adherence is also an important issue as well as individual efficacy, and VAS as well as other strategies to improve nutrition are required to maintain and reduce ocular complications of VADD in children.

Measles blindness prevention and treatment

Measles infection can cause corneal blindness as a result of several mechanisms, including acute vitamin A deficiency (from increased demand, low intake and malabsorption), measles keratitis and herpes simplex keratitis, particularly in African children. Several doses of high-dose vitamin A are recommended during measles infection, principally to reduce mortality, which is included in IMCI guidelines. Conservative estimates suggest that 1% of children hospitalised for measles subsequently go blind, which does not include unilateral blindness.[11]

The epidemiology of measles and measles blindness has evolved due to increased coverage of measles immunisation and VAS as well as socioeconomic development which has improved nutrition, housing and crowding. For example, in Tanzania, as measles immunisation coverage improved from approximately 30% to 80% between 1982 and 1988, the number of children admitted to a rural eye hospital with corneal ulcers associated with measles declined by 87% during the same period.[12]

WHO statistics show that measles immunisation coverage among 1-year-olds in the African region was 74% in 2013, and 78% in the South-east Asia and Eastern Mediterranean regions. An estimated 20.8 million infants were not immunised.[13] Between 2000 and 2015, the incidence of measles declined from 146 to 35 cases per million population.[14] However, in a recent study of children in schools for the blind in Ethiopia, almost half were blind from corneal scarring which almost certainly reflects the low coverage of measles immunisation and VAS.[15]

Ophthalmia neonatorum prophylaxis

Ophthalmia neonatorum, defined as conjunctivitis within the first 28 days of life, can be caused by a variety of organisms, reflecting the local epidemiology of untreated sexually transmitted diseases (STDs) during pregnancy. Ophthalmia neonatorum due to *Neisseria* gonococcus can lead to corneal perforation and rapid visual loss, with up to 16% of affected infants in LICs having corneal involvement at presentation.[16] Crede's prophylaxis was the original treatment which entailed cleaning the eyelids at birth and then instillation of topical silver nitrate solution and led to a marked reduction in blindness in children. As silver nitrate can cause chemical conjunctivitis, other topical antibiotics are now more commonly used, and more recently povidine iodine.

In high-income countries, ophthalmia neonatorum has become rare due to lower rates and better treatment of STDs in pregnant women, and ocular prophylaxis at birth. Universal ocular prophylaxis is recommended by the US Preventive Services Task Force based on the relatively high rate of gonococcal infection in the general population of 118.9/100 000 persons compared with the 19/100 000 target.[17] Globally, the prevalence of STDs remains high with 1 million incident cases in 2012, with 210 000 being due to chlamydia or gonorrhoea. Ninety-one per cent of these infections are in LMICs.[18] There is, therefore, a stronger case for universal ocular prophylaxis in LICs where rates of untreated STDs, particularly gonorrhoea, are likely to be far higher and where facilities for antenatal screening for gonococcal infection are inadequate.[18] However, recommendations regarding which prophylactic agent to use vary. The WHO/IAPB report of a scientific meeting on Preventing Blindness in Children recommends 2.5% aqueous solution of povidine iodine as prophylaxis.[3 19] The Canadian Paediatric Society recommends the following: 1% silver nitrate solution, or 0.5% erythromycin or 1% tetracycline ointment. The eyelids should be cleaned before instillation using a sterile swab for each eye, and the prophylaxis given within an hour of birth by the attending midwife or nurse.[20]

Even where universal prophylaxis is part of routine care it is often not undertaken. A study in Tanzania found that only 50% of births in dispensaries routinely applied ocular prophylaxis while 54% of deliveries took place there.[21] Often primary healthcare staff are not aware of the benefits and a pilot study showed that training primary healthcare workers in eye care increased their compliance with routine ocular prophylaxis.[8]

Face washing and trachoma

Trachoma, which is due to *Chlamydia trachomatis*, is the the most common cause of infectious blindness in adults, particularly in Africa, Asia and the Middle East. Trachoma is associated with poverty, overcrowding and poor personal and environmental hygiene. Active infection (conjunctivitis) is more common in children while the blinding complications occur in adulthood. Trachoma is estimated to cause visual impairment in 2.2 million people and irreversible blindness in 1.2 million people globally.[22]

Trachoma control uses the WHO-endorsed SAFE strategy (Surgery, Antibiotics, Facial Cleanliness, Environmental improvement) which entails 'Surgery' for adults with upper eyelid trichiasis, and mass drug administration of azithromycin ('Antibiotics') to reduce active infection. The aim of 'Facial cleanliness' and 'Environmental improvement' is to reduce transmission through improved access to water supplies and sanitation, with health education. Transmission occurs through close contact with eye and nasal secretions and by fomites and flies. Face washing in children is important as they are the main reservoir of infection. A Cochrane review, which identified only two randomised controlled trials, found only one trial which suggested that face washing combined with topical tetracycline may reduce active trachoma, and was inconclusive regarding whether face washing alone was effective.[23] However, a more recent review and meta-analysis of studies with a range of study designs found evidence to support face cleanliness which was generally defined as the lack of ocular discharge, nasal discharge, and/or flies on face at the time of clinical examination (OR 0.42, 95% CI 0.32 to 0.52), as well as the environmental components, such as access to sanitation (OR 0.67, 95% CI 0.55 to 0.78) of the SAFE strategy.[24]

Red reflex testing for cataract/retinoblastoma or other ocular abnormalities

Cataracts in children can be present at birth or develop during the first few years of life. If not detected early and operated on, late treatment can lead to amblyopia ('lazy eyes') and permanent visual loss. It is estimated that 200 000 children worldwide are blind due to cataract.[25] As a consequence of the reduction in blindness due to measles and VADD, cataract has become one of the major causes of treatable blindness in children in LICs. A systematic review of the epidemiology of childhood cataract found a wide range in the prevalence, from 0.2 to 22.9/10 000 children, with variation within as well as between regions. The review highlighted substantial gaps in the epidemiological data, particularly in LICs.[26]

Delay in surgery and the duration of visual deprivation before surgery are associated with an exponential decline in visual acuity after surgery. While there is some uncertainty regarding the optimal age of surgery for bilateral congenital cataracts, most paediatric ophthalmologists recommend surgery 4–8 weeks after birth. However, most children in LICs present far later than this for surgery. For example, in a study in Tanzania the mean delay between the cataract being detected and surgery was almost 3 years (median, 18 months).[27] While there are a number of factors which contribute to this delay, training health workers to test the red reflex of neonates to detect cataract and counsel the family is an important step.

Retinoblastoma is a rare but life-threatening eye cancer of childhood where survival and options for vision-saving surgery depend on the stage at presentation. LICs have the highest number of affected children due to high birth rates and the highest mortality rates. In Asia and Africa, 40%–70% of children with retinoblastoma die compared with 3%–5% in Europe and North America.[28] A white pupil, either noticed by the parents or detected by testing the red reflex, is the most common initial sign.

In most high-income countries, neonatal red reflex assessment is an essential component of newborn screening.[29] Currently, there are no specific guidelines in IMCI or child health programmes in LICs to test for the red reflex or training for primary health workers.

Traditional eye remedies

The use of traditional eye remedies is well documented in children as well as adults.[30] Some remedies are harmless while others are potentially harmful, such as instilling infusions made from vegetable matter, hot oil, human urine (which may be infected), or products which are acidic or alkaline. Many of the latter can cause trauma or corneal infection. They can therefore cause or exacerbate anterior segment eye disease, and lead to a delay in seeking more appropriate care.[31] Reasons for using these remedies include inadequate eye care services, greater accessibility for patients, lower cost, better communication between healer and patient and cultural beliefs, combined with low levels of education.[30] Educating mothers on the potential harm of traditional eye remedies at the primary level can address awareness, recognising there are other important elements to be addressed.[31]

Trauma

There are approximately 1.6 million people blind from ocular injuries and almost 19 million with unilateral blindness or low vision.[32] It has been estimated that 3.3–5.7 million children sustain eye injuries annually.[33] There are very little data specifically for LICs or children. Early diagnosis, referral and treatment are key for the visual prognosis following an eye injury. Delays in seeking medical attention are known to occur in particular in LICs, and lead to worse visual prognosis.

PEC for children

Despite evidence of efficacy and good rationale for many of the individual components of the 10 activities recommended by WHO for children, there is little evidence that these have been implemented or evaluated as a comprehensive package. In a small pilot study in primary health clinics in Dar es Salaam, 30 staff were trained using materials based on WHO's 10 key activities. The study showed that pretraining knowledge of eye conditions was poor with poor case management, and some clinics had stopped ocular prophylaxis as they did not know why it was used. Knowledge improved after training, ocular prophylaxis was reinstated and staff included eye conditions in their health education sessions for mothers.[8] PEC for children is a complex intervention, comprising different elements some of which act independently while others may interact. Evaluation of the whole package is, therefore, important as individual components may not have the desired impact because all the elements required for effectiveness are not in place.

INTEGRATING EYE CARE INTO PRIMARY LEVEL CHILD HEALTH SERVICES THROUGH IMCI

IMCI is an integrated approach to child health that focuses on the whole child and aims to reduce death, illness, and disability, and promote improved growth and development in children under 5 years of age. The central component is the training of primary healthcare workers currently in nine topic areas, which include ear problems and care of the well child. There is a noticeable lack of promoting eye health and visual development, and the management of eye problems.

Integrating eye health into IMCI means these primary care workers will know how to prevent, detect and refer eye conditions in children. Several of the strategies are already components of IMCI. Expansion to include eye conditions would, therefore, strengthen existing elements of IMCI as well as add new elements including skills in eye examination and the red reflex for newborns.

The direct costs of providing PEC are minimal as no new medications would be required and the only equipment needed would be to test the red reflex (US$10 each). The benefit of PEC for children as an integral component of the continuum of care is potentially enormous in terms of preventing blindness in children and increasing access to special education and rehabilitation by incurably blind children.

CONCLUSIONS

Reducing blindness and visual loss in children remains a high priority in global eye health policy but there has been limited progress in implementing PEC for children as a key component of the continuum of care, despite evidence of effectiveness of many of the strategies.

As well as increasing access to high-quality tertiary eye care, PEC for children must also be addressed. Given the efficacy of many of the individual components of PEC, there is an urgent need to evaluate the effectiveness of integrating this package of interventions, and use the findings to advocate for policy change to increase coverage and access to PEC for children at global and national levels.

WHO definitions

- Blindness: visual acuity less than 3/60 or a corresponding visual field loss to less than 10° in the better eye with the best possible correction.
- Low vision: visual acuity of less than 6/18 but equal or better than 3/60, or a corresponding visual field loss to less than 20°, in the better eye with the best possible correction.
- Visual impairment: includes both low vision and blindness. Reference: VISION 2020 Global Initiative for the Elimination of Avoidable Blindness: action plan 2006–2011
- Bitot's spots: superficial keratin deposits on the conjunctiva, which are oval, trianguar or irregular in shape. Bitot's spots are a sign of chronic vitamin A deficiency and are associated with conjunctival dryness (xerosi)
- Keratomalacia: ulceration or melting of the cornea of the eye due to severe, acute vitamin A deficiency.

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