Vision Testing and Screening in Young Children

Background

Childhood vision development[1]

Early visual development sits on the border between ophthalmology and psychology with an element of mystery thrown in. Early development is largely marked by qualitative milestones but, from about 12 months onwards, quantitative measures can be made, the accuracy of which increase with the child’s age:

- **0-1 month** - baby turns to diffuse light and shows steady fixation. There are irregular horizontal pursuit and ‘brightening’ (the eyes widen and other movements are stopped when shown an interesting visual stimulus).
- **2-3 months** - there is visually directed reaching and the baby starts to be more proficient in accommodating. By now, the most rapid visual development will have occurred and further changes are more progressive.
- **3-5 months** - there is blinking to threatening stimuli and the baby starts to mimic facial expressions. Objects are examined in more detail.
- **6-12 months** - the baby’s vision rapidly approaches normal adult acuity and vision motivates and monitors movement towards a desired object. By a year old, near and distant acuities are good. There may be some mild hypermetropia but there is ability to focus and accommodate and the child has depth perception. They can discriminate between simple geometric forms, scribble with a crayon and are visually interested in pictures.
- **By 2 years** - myelination of the optic nerve is completed. All optical skills are smooth and well co-ordinated and acuity is now normal.
- **By 3 years** - retinal tissue maturity is almost attained; there is slower ongoing development for another four or five years until complete.

The young child’s retina continues to develop rapidly until the age of 2 to 3 years. Thereafter, development slows until its completion at age 7 or 8. Screening aims to catch problems before development is complete, thus avoiding amblyopia which occurs when the developing retina is not stimulated due to the image not reaching it or ocular misalignment.

The needs of children with ophthalmic disorders vary substantially according to whether these are isolated or part of a complex of other impairments or diseases, as well as by the level of visual loss experienced.

Epidemiology of childhood visual loss[2][3]

The majority of children in the UK with severe sight impairment (determined as corrected acuity worse than 6/60 or worse) have additional and often multiple serious motor, sensory or learning impairments and/or serious chronic diseases.

Serious visual loss in childhood is relatively uncommon; each year, 6 per 10,000 children in the UK develop severe sight impairment by their 16th birthday. Each year a further 12 become visually impaired (worse than 6/18). The prevalence of visually impaired or severely sight impaired children is 2 per 1,000.
Children with milder visual loss, unilateral visual problems or eye disease without visual consequences considerably outnumber those with more serious disorders. In the long term, they require more of the disproportionately small resources available to them than the minority with more serious problems. Major refractive errors occur in 5% to 7% of preschoolers and early screening has been associated with a decrease in the prevalence of amblyopia and improved acuity. Screening before 3 years of age is associated with a 70% lower prevalence of amblyopia after treatment. The beneficial effects of early identification of vision problems are far-reaching, as childhood visual impairment can have a significant developmental, emotional and social impact. However, a Cochrane review recently concluded that the benefits of a screening programme are not yet established by evidence and further research is needed.

Globally the major causes of severe sight impairment in children are vitamin A deficiency, trachoma, and other infections.

**Screening for ophthalmic problems**[2] [4] [5] [6] [7]

**Neonatal and early screening**
This is aimed at the primary prevention of visually impairing disease (eg, cicatricial retinopathy of prematurity) as well as reducing the impact of already established disease (eg, early detection and treatment of congenital cataracts). Most children with severe sight impairment (6/60 or worse) have additional sensory, motor or learning impairments ± chronic disease.

**Preschool screening:** The main target condition is amblyopia, although the UK National Screening Committee (NSC) vision screening programme includes strabismus and uncorrected refractive error as target conditions. The use of near vision testing is not currently recommended. There remains uncertainty about how and when to most effectively screen for refractive errors; however, an undiagnosed refractive error can contribute to a cascade of events affecting a child's achievement of educational and personal potential.[8]

Conditions that are screened for broadly fall into one of four (overlapping) categories:

- **Neonatal conditions** - eg, retinopathy of prematurity, retinoblastoma, cataracts. Some of these conditions need treatment irrespective of visual outcome whereas for others the purpose of treatment is to improve visual outcomes.
- **Risk factors for amblyopia** - eg, cataract, retinoblastoma - identification of amblyopia in the preschool age is associated with good treatment prospects but, beyond 7 or 8 years of age, a decrease in cortical plasticity limits the outcome.
- **Refractive errors** - anisometropia (difference in refractive error between the two eyes) is the most common cause of non-strabismic amblyopia and usually develops between 2 and 4 years of age.
- **Colour vision abnormalities** - these are often not picked up until later but they are important in that there is evidence to suggest that this affects learning and it excludes individuals from certain jobs (eg, electrician, train driver).

For more information on the more common conditions screened for, see separate Amblyopia, Strabismus (Squints), Refraction and Refractive Errors, and Colour Vision and its Disorders articles.

**The newborn examination and 6- to 8-week review**[6]

This should include:

- The red reflex: use an ophthalmoscope about 30 cm from the infant's eyes. Dark spots in the red reflex can be due to cataracts, corneal abnormalities, or opacities in the vitreous. The red reflex may be absent with a dense cataract.[9]
- Corneal light reflex to detect squint. Hold a penlight at arm's length in front of the child. When the child looks at the light, normally the light reflex is symmetrical and slightly nasal (medial) to the middle of each pupil.
- General inspection of the eyes may suggest other conditions. For example, one eye larger than the other may indicate glaucoma.
- Also at the 6- to 8-week examination, ask parents if they have any concerns about their child's vision.
A specialist examination is indicated:

- When an abnormality is detected in the above routine examinations. In particular, an abnormal red reflex requires same-day referral as vision rapidly deteriorates week on week past six weeks and permanent severe sight impairment in the affected eye may be averted with prompt treatment.
- Where there is a known higher risk of visual disorders - eg, babies of low birth weight at risk of retinopathy of prematurity, babies who have a close relative with an inheritable eye disorder like albinism or Usher's syndrome and babies with known hearing impairment. Congenital rubella syndrome is currently rare but may return with a falling uptake of the measles, mumps and rubella (MMR) vaccine.
- Where there is persistent or fixed squinting - intermittent squints are common in neonates, particularly when they are tired. However, this should have resolved by about 3 months of age. If a persistent squint is detected the baby should be referred. Intermittent squints need assessment of frequency and nature and a further review, asking the parents to note when the child is squinting and for how long. Ask if the baby appears to be trying to focus on objects (notably, lights, faces and brightly coloured toys). If, over this time, parents have not noticed the baby trying to fix its gaze on an object or if the periods of squinting are getting longer, referral is indicated.
- The American Academy of Ophthalmology recommends visual assessment from birth and at all routine health supervisory visits. The child's anatomy and function should be checked at regular infant and well-child visits and visual acuity should be assessed at the preschool stage as well as when there is a complaint. Infants with a known risk (retinopathy of prematurity, Down's syndrome, etc) or significant family history (congenital glaucoma, strabismus) should be referred for further evaluation.

Preschool screening

Currently, all children aged 4-5 should have a vision check prior to or as a part of school entry (this policy is due to be reviewed but is not expected to change). This check is carried out by the school nurse or by an orthoptist, depending on local policy. Most 4 year-olds can co-operate with a test of visual acuity; there are several different assessment methods appropriate for young children, varying from picture or shape tests to matching tests and, for those children able to, the Snellen chart. There is some scepticism on the value of this test with systematic reviews showing mixed evidence to support its effectiveness.

In the UK a randomised controlled trial compared visual surveillance by health visitors and family practitioners with orthoptist assessment and concluded that photorefraction (detecting refractive errors with digital camera-like equipment) and a cover test (to detect strabismus) at age 37 months would have the best sensitivity and specificity of a range of vision screening methods examined. However, the costs of this would be prohibitive in many countries.

Screening in school-aged children

The role of vision screening after school entry is controversial. There is ongoing debate as to whether these are cost-effective screening tests, although many researchers point out that lack of evidence is not evidence of absence. The main issue lies in detecting refractive errors. Unnoticed, these can cause a number of problems ranging from the specific problems (eg chronic headaches) to underachievement academically. This can have a very broad impact on the child's future. However, the benefits of screening at this age are still not clear and, whilst local screening policies should not be changed, it is not recommended that new programmes be set up for this age group.

High-risk groups

Some children are at particular risk of developing visual problems and should be subject to surveillance. These include children with:

- Sensorineural hearing impairment.
- Neurodevelopmental problems (including Down's syndrome).
- A family history of a childhood-onset ophthalmic disorder - eg, retinoblastoma.
Visual (and auditory) assessment should also be considered in the assessment of children with suspicions of:

- Learning difficulties or pervasive developmental disorders.
- Behavioural disorders - problems of vision and hearing may also present as a behavioural disorder or with symptoms suggestive of attention deficit hyperactivity disorder.
- Reading difficulties - defined as an inability to read at an expected level despite intelligence being within the normal range. Reading difficulties affect up to 10% of the population of school age and can be isolated or part of a wider spectrum of problems. They may be associated with refractive errors or ocular motility disorders, although they are more commonly due to problems unrelated to the eye. Children with dyslexia tend to have an associated writing difficulty.
- Parental concerns about vision should always be taken seriously and ophthalmological review is generally recommended.

NB: eye checks by optometrists are free to children aged under 16 (under 19 if in full-time education). Parents of older children and teenagers should be encouraged to use this service, particularly if there is a family history or myopia.

Further reading & references

2. Ophthalmic Services for Children; Royal College of Ophthalmologists, 2012
3. Screening for vision defects in children aged 4 to 5; UK National Screening Committee, 21 November 2013 (archived content)
4. Child Health Surveillance and Screening: ACritical Review of the Evidence ; Centre for Community Child Health, Royal Children's Hospital Melbourne, National Health and Medical Research Council, March 2002
5. The UK NSC recommendation on Vision defects screening in children: Systematic population screening programme recommended; UK National Screening Committee, December 2013 (archived content)
9. The UK NSC recommendation on Congenital cataract screening in newborns; UK National Screening Committee, July 2006 (archived content)
10. Pre-school vision screening; Bandolier

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