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Effective Health Care

Bulletin on the effectiveness of health service interventions for decision makers

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Pre-school hearing, speech, language and vision screening

- Child health screening focuses on the early detection of childhood disorders in order to reduce disability. This includes screening for hearing, speech and language and vision problems in pre-school children.
- Screening for permanent childhood hearing impairment is usually carried out by health visitors using the infant distraction test (HVDT) at 6–9 months. This test fails to detect a significant number of hearing problems sufficiently early.
- There is good evidence that universal neonatal hearing screening is more effective and cost-effective than HVDT at detecting significant congenital hearing loss.
- A significant number of pre-school children show signs of speech and language delay at some point. Delay which would not spontaneously improve can be effectively treated. However, it is not yet clear how to identify children who will fail to progress without treatment.
- Pre-school vision screening for refractive errors and non-obvious squints may not be beneficial because these minor conditions, by themselves, do not appear to be problematic and because the advantages of treating them have not been demonstrated. Major defects are identified without screening.
- The direct research evidence that amblyopia in young children is disabling and can be effectively treated is weak. However, there is strong clinical opinion that identifying and treating amblyopia at an early age produces benefits. Better research is required to provide a clearer picture of the likely benefits, harms and costs of pre-school vision screening.
- NHS organisations may wish to review their hearing screening in the light of this evidence but further change is not recommended in advance of the advice from the National Screening Committee and/or further research.

The contents of this bulletin are likely to be valid for around one year, by which time significant new research evidence may have become available.

A. Pre-school screening

Child health surveillance (CHS) is part of a broad set of activities initiated and provided by professionals. The objective is to reduce childhood disability by identifying and managing a multiplicity of conditions at an early stage and by working with families to promote child health and well-being.[1] CHS includes a number of screening programmes which are focused on the detection of specific disorders.

CHS began as a series of activities which tended to come together in an ad hoc manner. The value of surveillance and monitoring of child health, growth and development used to be regarded as self-evident. The Hall reports emphasised the importance of applying rigorous criteria for screening programmes in community child health and helped to produce a more co-ordinated national programme.[2–4] However, there is still significant variation both within and between health authorities in the content, timing and delivery of CHS.

This bulletin summarises the research evidence about hearing, speech and language and vision screening and is based on recent systematic reviews commissioned by the NHS Health Technology Assessment Programme. Details of the methods and the results are available in the full reports.[5–7] This bulletin aims to provide easy access to this research intelligence, to promote informed debate and help decision makers.

These three reviews focus on only some of the components of CHS and, within those parts, have not necessarily examined all the disorders being sought through screening. Some of the disabilities for which children are screened in the early years can exist alongside one another and with others which have not been reviewed, such as conductive hearing loss and developmental disability. Some important components remain to be scrutinised as does the value of the programme in its entirety. Therefore, changes to component parts of the programme should only be made after consideration has been given to the consequences of these changes to the programme overall.

The Department of Health's National Screening Committee has recently established a sub-group to examine neonatal and childhood screening and surveillance. This will be making recommendations on the direction of future screening and surveillance. The Department of Health recommends that no changes are made to existing child health screening programmes until this committee has reported and/or further research has been completed and considered.

B. Evaluation of screening

The objective of universal screening in childhood is to identify impairments which are not obvious or apparent, which will cause *significant* disability or handicap and for which early treatment is more effective. Screening does not include situations in which potential problems are noticed and then referred for detailed evaluations. Screening uses considerable resources, and imposes tests on children who are not ill. In addition, it has been argued that some screening programmes could be potentially harmful due to the unnecessary worry, referrals and procedures which may result. There is, therefore, an ethical responsibility to ensure that screening is only carried out where there is confidence that it will result in more good than harm. 'It is unethical to offer screening tests which cannot stand up to critical examination'.[4] A number of criteria are helpful when considering whether or not to carry out screening (Table 1).[8,9]

This rational approach to screening is at odds with conventional views held by some practising clinicians and parents that any disorders should be detected early if possible. These often powerfully held views do not justify the establishment or maintenance of a screening programme which is not supported by the research evidence. Ultimately, policy decisions have to be made by integrating the available evidence, incomplete though it may be, and assessing the relative values of different opportunities to improve health. This needs to take account

Table 1 Major criteria for assessing a screening programme

Does the screening programme do more good than harm and at acceptable cost?
• Is the impairment sufficiently common to justify screening all children?
• Does the impairment cause significant disability or handicap?
• Is there agreement about what is meant by a case?
• Is there a screening test which accurately identifies children who may have an impairment?
• Is there an agreed and available effective intervention with which to treat the impairment or reduce the disability after identification?
• Is there an advantage in detecting and/or treating the impairment earlier, before it becomes clinically observable?
• Is the cost of screening justified by the net benefit?

of the fact that screening programmes can also provide opportunities for health professionals to undertake other activities, for example, health promotion. The removal of specific activities may unwittingly result in an overall loss of service without necessarily resulting in a corresponding time or cost saving. In the final analysis, policy may be driven by social or political concerns, informed by the scientific evidence, and individual choices made by parents after having been adequately informed about likely benefits and harms.

Even when there is good evidence to support a screening activity its benefits are only fully realised if the programme is well managed and there is quality assurance. This may be difficult since many childhood screening programmes now involve several NHS trusts and professional groups and are also undertaken in GP settings. Routine data collection is needed to monitor programmes in terms of coverage, sensitivity and specificity and the progress of those children screened positive – a requirement rarely met at present.

C. Hearing screening

C.1 Epidemiology and natural history of congenital hearing impairment: Approximately 840 congenitally hearing-impaired children are born in the UK each year (1.12 per 1000 live births) with a permanent bilateral moderate, severe or profound hearing impairment of > 40dB hearing loss in the better ear.[10] There are two types of hearing impairment: *sensorineural hearing loss* (SNHL) caused by lesions in the cochlea or auditory nerve and its central connections (unilateral or bilateral) and *conductive hearing loss* due to pathology of the middle ear e.g. glue ear. The vast majority of permanent childhood hearing impairment is sensorineural, which does not resolve.

Almost 85% of all permanent childhood hearing impairment will be present at birth with around 160 cases a year being acquired (often following meningitis). The impact of permanent hearing impairment on children and their families can be considerable. Late identification may compound problems in communication, language acquisition and affect other areas of development.

C.2 Screening tests: The most common pre-school hearing screening test used in the UK is the infant distraction test carried out by two health visitors (HVDT), or by a health visitor and a trained assistant (Table 2). It is administered at about 6–9 months of age and assesses the infant's ability to turn and locate a sound source. It is used as a universal hearing screen in about 98% of health districts and achieves

Table 2 Key screening tests used to detect permanent childhood hearing impairment

Tests		Comments
1	Infant distraction test (IDT)	
1a	Traditional Health Visitor distraction test (HVDT) universal in most districts	Test carried out at 6–9 months, usually in protected time. Cost about £25 per test including follow-up[a]
1b	Targeted IDT	Proposed in tandem with universal neonatal screening on equity grounds
1c	BeST test	New one person IDT, with calibrated sound source
2	Transient Evoked Otoacoustic Emissions (TEOAE)	Quick test carried out within days of birth. Measures acoustic energy generated by the healthy cochlea in response to wide band clicks using a lightweight ear-canal probe. Cost £14 per test. Presently most used for well babies. Need agreed criteria for Pass/Refer
3	MLS TEOAE	New very quick version of TEOAE that may have advantages in noisy situations
4	Distortion Product Otoacoustic Emissions (DPOAE)	Many implementations, need to monitor literature as to outcome
5	Auditory Brainstem Response (ABR)	Test carried out within days of birth. Wide band clicks are presented to one ear and the resulting electrical potentials of the early auditory pathways are measured using surface electrodes. Some ABR machines make pass or refer decisions, others need trained operators. High recurrent costs or long test times on some implementations. Presently most used in NICU/SCBU children
6	Portable Auditory Response Cradle (PARC)	Automated, quick, behavioural test which presents a 70–80dB SPL high pass noise to one or both of the baby's ears via an earphone or probe. The baby's response is measured by a cradle and associated computer software which compares head turns and body movements in periods with the sound on and off. An automated decision algorithm is used to pass or refer. Probably good for severe and profound impairments

[a] The full cost of health visitor (HV) time does not allow for the fact that HVs may be visiting the home anyway. However, if done in conjunction with several other activities its accuracy and therefore its value is likely to be reduced.

coverage of about 90% of all infants. This varies by socio-economic status. There is also variability in the way it is carried out, the sound generators used, the number and level of training of the people doing the testing, and the adequacy of soundproofing of the room. This leads to concerns about the number of children with problems who are not identified during a screen under present arrangements.

The published evidence on test performance from clinic-based retrospective studies and case-note reviews indicates poor and variable sensitivity (detection rate) and specificity (true negative rate) for the HVDT.[5] The cumulative yield is low, being about 50% by 18 months of age. The average age of confirmation of hearing impairment via the HVDT is between 12–20 months, with subsequent age of hearing-aid fitting following HVDT being about 18 months.

Alternatively, a number of neonatal screening tests that can be applied within the first few days after birth are available (Table 2). These methods include the Portable Auditory Response Cradle (PARC), the Auditory Brainstem Response (ABR), and Transient Evoked Otoacoustic Emissions (TEOAE). TEOAE is currently the preferred technique for well babies, and automated ABR for those in neonatal intensive care or special care baby units. Although the PARC has been extensively tested, its implementation has not been as well evaluated in multi-centre studies as TEOAE.

One controlled trial has been carried out to compare screening methods.[11] This trial in Wessex compared 21,000 babies given TEOAE screening (ABR was used for those failing the test) with 29,000 babies who received only the HVDT at 6–8 months. Interim results show that the neonatal screening test has a specificity of around 98% and gave a yield of 1.1 per 1,000 births by 4 months of age. This corresponds to the expected prevalence rate, thus indicating a high sensitivity. The high specificity and sensitivity of the neonatal screen is confirmed by another UK longitudinal study.[12–14] The cumulative yield in the HVDT-only group was lower at 0.7 per 1,000 by 18 months old suggesting that false negatives will emerge later on. Only 0.1 hearing problems per 1000 births were actually detected by the HVDT since most were identified due to parental or professional concern, or passed the HVDT incorrectly. In the neonatal screening group 96% were identified under 9 months of age compared to around half in the HVDT-only group.

In the UK, where universal neonatal screening programmes have been implemented with good coverage alongside the HVDT screen, the extra yield of the HVDT is very low (e.g. 0.1 per 1000 births).

C.3 Interventions for congenital hearing impairment: Interventions include amplification, cochlear implants or helping the child to learn an appropriate sign language (Table 3). For children with a profound impairment a cochlear implant may enable the auditory neural pathway to be stimulated directly. This is currently being evaluated by an MRC study.

While there is a growing body of literature on the benefits of early intervention, few studies are of high quality. Three of the 18 studies identified provide reasonable evidence that early intervention is better than late. In a study of 69 children identified by a Colorado neonatal screening programme, those habilitated before 3 months of age scored 87% of normal for expressive language, compared to only 66% for those habilitated between 3 and 12 months.[15] Similarly, in the same study, 46 children whose hearing impairments were identified before the age of 6 months were found to have better 3-year vocabulary and expressive and receptive language than 63 children whose impairment was identified after 6 months (after having taken into account any differences in non-verbal cognitive skills).[16] In another study, subjective assessments by teachers of speech intelligibility of 153 children (matched for age, sex, age of onset of hearing loss, degree of deafness and schooling) found that those fitted with hearing aids before 6 months achieved higher scores than any groups of children fitted with hearing aids later in life.[17]

The benefits of early identification in hearing-impaired children are supported by other studies which show earlier onset of babbling[18] or better communication skills[19,20] the earlier the children were fitted with hearing-aids. One study, however, found that the initial benefits of early intervention on receptive language did not persist.[21]

Overall, this research supports the view that these children (particularly those with more severe impairments) have very poor outcomes at present compared with normal-hearing children. Earlier identification is associated with better outcomes, particularly in the domain of language acquisition and communication. However, the extent to which even better outcomes may be achieved with very early identification is not yet clear, although the early research results from Colorado point to this being the case.[16]

C.4 Cost-effectiveness: There is a significant difference in the cost of neonatal and HVDT screening approaches. The cost (including follow up) for universal neonatal screening programmes is about £14,000 per 1,000 births; for HVDT it is about £25,000 per 1,000 children, when done in protected time or on a separate visit.[22] This translates into a 'cost per child with a hearing problem identified' of around £17,000 for neonatal screening and £80,000 for HVDT screening. These figures do not take into account any of the benefits to the child of earlier

Table 3 Key interventions for moderate to profound permanent childhood hearing impairment and ways they will be affected if Universal Neonatal Screening is introduced

Intervention	Effect of Universal Neonatal Screening
Family support, advice and information	Needs to be effective from screen refer and onwards. Requires better multi-agency co-operation
Provision of hearing aids	Better early diagnostic testing and aid fitting. Requires evaluations for mild impairments if the screen is to be extended to this group
Provision of communication support (spoken and/or signed)	Earlier support needed
Provision of pre-school educational support	Earlier support needed. Different skill mix needed for children in first 18 months
Cochlear implants	Earlier implantation will be possible
Provision of other devices e.g. radio aids, tactile aids, other assistive devices	No effect

detection and habilitation nor the extra costs of the earlier treatment and educational support which they will receive with neonatal screening. Conversely, it does not take into account other health promotion activities which may be undertaken by health visitors at the same contact. However, in the majority of districts, hearing tests are carried out by health visitors in separate clinics or during protected time. Therefore, many health authorities will be able to free some resources in moving from HVDT to universal neonatal hearing screening as well as improve the service.

Approximately two-thirds of districts have some sort of neonatal hearing screening programme: two have universal neonatal screening and the remainder target babies with one or more risk factors for hearing impairment. Because this means screening fewer but higher risk babies, targeted screening is more cost-effective at around £14,000 per case detected. However, only about 50–60% of hearing-impaired children will have risk factors and in practice the yield will be lower.[5,22]

D. Speech and language delay

D.1 Epidemiology and natural history of speech and language delay: Speech and language delay is one of the most common neuro-developmental difficulties in early childhood[23] with a prevalence of around 6% of children. The demand for services, particularly for children under 4 years of age, is increasing.[24,25] Since the age distribution at which 'normal' children learn to speak is probably 'bell-shaped', prevalence estimates are dependent to a great extent on the cut-off point used. Few data are available on bilingual or ethnically diverse groups and the association with social class is also unclear.

Spontaneous remission of speech and language delays identified in the pre-school period can be high, particularly for children with specific expressive delays, where some 60% of cases may resolve without treatment by 3 years of age.[6] The picture for older children is unclear because of a lack of research, but it is evident that if children go on to have difficulties in the first year of primary school, they are at risk of experiencing problems throughout their schooling. In addition, 41–75% of children who present with early expressive language delay were found to exhibit reading difficulties at 8 years of age.

Risk factors for persistent problems include the initial severity of the delay, the extent to which the difficulties are generalised across speech and language, and the

Table 4 Principal methods of screening for speech and language delay

- Level of concern elicited from parent by a professional (the Parental Evaluation of Developmental Status)
- Parent provides information about speech and language milestones and the clinician interprets the results (the Early Language Milestone Scale, the Clinical Linguistic Auditory Milestone Scale)
- Parent reports on child's current level of speech/language functioning and the clinician interprets the results (e.g. the Minnesota Child Development Inventory, the Ward Infant Language Screening Test, the Language Development Survey)
- Clinician makes a judgement of child's performance based on mixed observation/reported data (The Denver Developmental Screening Test)
- Clinician tests child's speech and language performance by means of specific activities such as:
  - the *child's response to requests graded in terms of difficulty* (e.g. the Hackney Language Screening Test, the Mayo Early Language Screening Test, the Uppsala General Language Screening)
  - the *child's capacity to imitate words and sentences* (Sentence Repetition Screening Test)
  - the *child's capacity to retell stories*

extent to which other cognitive and developmental skills are also delayed. The extent to which factors such as social class, family history, temperament and gender contribute to relative risk is unclear. However, there is reasonable evidence to suggest that speech and language development are affected by how well parents interact verbally with their children and by the general level of stimulation within the home environment. However, it is uncertain whether parental factors can actually create a 'clinical' level of difficulty.

D.2 Screening tests: Several screening measures are used in the UK (Table 4). No randomised controlled trials (RCTs) of screening programmes were identified by the review. Screening test performance varies considerably with sensitivity within the range 17–100% and specificity in the range 43–100%. Sensitivity was generally lower than specificity, particularly in the better-quality studies. This suggests that it may be easier to indicate those children who are not cases than to be clear about those who are. Few studies have attempted to compare the application of two or more screening tests to a single population or to compare a single screening measure across different populations. It is, therefore, difficult to make a judgement about the relative value of different procedures or to single out any one measure as outperforming the others. In general, however, screens that used parents as informants were as accurate as those that used formal testing procedures.

The majority of the screening procedures currently available are applicable after the age of 2 years when the reported accuracy of screening is greater. However, work currently in progress is exploring a method of identifying those at risk of subsequent difficulties based on auditory skills at 9 months old.[26] Given the variability in the natural history of speech and language delay, and the high level of subsequent spontaneous improvement, particularly in the very early years, the use of a single measure at this stage in a child's development is unlikely to be valuable. Tests that can identify those children who will fail to progress without treatment need to be developed.

D.3 Interventions for speech and language delay: Several types of interventions have been used for helping children with speech and language delays (Table 5). Ten RCTs and 12 controlled studies were identified which evaluated treatment, mostly for problems of articulation/phonology and expressive language.[27–45]

These studies show that interventions are effective in enhancing speech, expressive language, receptive language and auditory discrimination, relative to untreated controls. The size of the benefits represented progress from the 5th to the 25th percentile on a norm-referenced test. This corresponds to an overall standardised effect size of around 1.0 – an increase in the average performance equivalent to 1 standard deviation of the distribution of performance scores. These results are supported by data from 26 single-case experimental designs.[6] No studies specifically compared the effects of different timing of interventions on social and educational outcomes and there are little reliable data with which to identify the best choice for any area of delay.

One of the interesting issues is who most effectively provides the interventions: professionals (i.e. speech and language therapists or specialist teachers) or parents/others in the child's environment. Studies have shown comparable results for both in the case of expressive language (effect size from 0.65–1.11 and 1.08–1.16 for professionals and parents respectively). In speech delay, professionals (effect size from 0.94–1.11) were more effective

Table 5 Key intervention approaches for speech and language delay

The majority of interventions are primarily behavioural in nature and may be provided by speech and language therapists or specialist teachers, either intensively within a specialist unit or less intensively, but at regular intervals, in a clinical setting, a school or a day care setting. The three main intervention types are:

Didactic intervention

The child is given a model of a sound, a word, a communication behaviour or a syntactic construction and an attempt made to elicit the child's production of that model using positive reinforcement. This approach is usually carried out by the therapist or teacher.

Naturalistic intervention

This approach recreates the environment which is known to optimise the child's language learning opportunities, not through explicit instruction, but by making the stimulus relevant to the child's focus of attention. This approach is aimed at promoting the acquisition and generalisation of functional language and frequently involves parents as active participants. It can be carried out directly by a therapist or teacher or indirectly by others in the child's environment.

Hybrid intervention

This approach combines elements of both didactic and naturalistic interventions. It recognises that children with delayed speech and language development may learn language in different ways from one another and from their normal peers, and may need to be exposed to a range of different types of environmental modifications.

Other intervention approaches include **non-directive therapy, auditory training, comprehension monitoring and cognitive therapy.**

than parents (-0.02 to 0.20). In the case of receptive language the reverse was found – treatment provided by parents or other carers on the advice of a professional following diagnosis or assessment was more effective (average effect size of 1.43) compared with direct intervention (average effect size of 0.02).

D.4 Cost-effectiveness: No cost-effectiveness studies have examined the impact of screening programmes in terms of possible savings in special education and other support services provided. One study is currently underway at Erasmus University, Rotterdam. There is, however, evidence from the US which suggests that home-based intervention may be more cost-effective.[46] Given the positive effects of indirect intervention identified in this bulletin, this needs to be examined more closely in the UK context.

E. Pre-school vision screening

E.1 Epidemiology and natural history of asymptomatic vision problems: The aim of vision screening at the age of 3–4 years is the prevention or reduction of disability due to one or more of the following target conditions: *amblyopia* (reduced visual acuity, usually in one eye, in the absence of organic disease which cannot be improved by spectacles), *refractive errors*, and the types of *squints* which are not cosmetically obvious and so are unlikely to be detected without screening (phorias and microsquints).

No studies were found which had the primary aim of establishing the prevalence of visual defects at 3–4 years of age. However, data from studies of primary orthoptic screening programmes for this age group reported a range of yields for the target conditions of 2.4–6.1%.[47–55]

No studies were found which aimed to document the natural history of these conditions in untreated pre-school children. A few studies, however, give some information on what would be expected to happen to the vision of children at this age with amblyopia,[56] squints,[57,58] and refractive errors[59] in the absence of intervention. These suggest that amblyopia in some children (due to non-cosmetically obvious squints or mild refractive error at 3 or 4 years) may resolve without treatment. However, there are many important gaps in the data.

Twenty-one studies were found which aimed to investigate whether a variety of disabilities were associated with any of the three target conditions. The majority of studies compared the performance of children with visual defects in tasks such as reading with that of their peers with normal vision, or compared the vision of children with and without disabilities such as dyslexia. The only strong and consistent relationship to emerge is that children with myopia perform better than their peers on reading tests, (although this is not due to myopia enhancing child development).[60–63] Studies that investigated the relationship between squints and reading ability produced inconsistent findings.[64–67] However, children with squints have been found to perform less well than their peers without squints in neuro-developmental tests.[68–70]

Amblyopia in one eye can disrupt depth perception, but the effects that this might have are poorly understood and are currently the subject of debate.[71–73] The only study found which investigated the perceptual difficulties associated with amblyopia in adulthood suggested that amblyopia in one eye had little impact on perception of space or contrast and was unlikely to affect everyday life, although this study was methodologically flawed.[74] No studies have been carried out using a design which is appropriate for establishing a causal link.

Physiological data from animal studies showed that blurred vision at a critical stage of neurological development could result in permanent impairment of the relevant brain functions. This gave rise to the enthusiasm for early detection of amblyopia. However, the quality of the literature on visual defects and disability, and on the natural history of these conditions in humans, is insufficient to know with any certainty what might be expected to happen in an individual child with amblyopia, a non-cosmetically obvious squint or a refractive error if they were left untreated. One large RCT in Avon comparing vision screening programmes in children aged under 3 should provide useful information on associated disability in older children.[75] There is a very strong professional view, however, that amblyopia is disabling and should be treated.

E.2 Screening tests: The principal aim of the child screening test is to identify children with amblyopia. However, tests are also carried out for non-cosmetically obvious squints and refractive errors because these may be associated both with amblyopia and also sometimes with the aim of treating them in their own right (Table 6). No RCTs of screening programmes for the 3–4 year age group were identified. One prospective controlled study was found, which compared visual outcomes at the age of 7 years in children who were screened at age 3 by orthoptists, general practitioners or health visitors in Newcastle.[56] Children with straight-eyed amblyopia and refractive errors were identified significantly earlier in the orthoptic screening cohort, but there was no difference in the time of identification of obvious squint. Despite the fact that many more children with amblyopia were identified and treated in the orthoptic screening cohort, the prevalence of amblyopia at 7 years of age was the same in all three cohorts.[56] However, this study has certain methodological weaknesses.

Table 6 Common contents of pre-school vision screening

Common pre-school vision screening tests

- Checking the appearance of the eyes
- Cover/uncover test for squint
- Single optotype or linear visual acuity test e.g. Sheridan Gardiner or Snellen

Additional tests performed in primary orthoptic screen

- Ocular movements
- Convergence
- Prism test
- Test of stereoacuity e.g. Fisby or Lang stereotest

Sixteen other studies that aimed to establish the effectiveness of pre-school vision screening were either observational or audits.[47–50, 52–55, 76–83] Uptake rates for primary orthoptic screening ranged from around 44–80%. Vision screening by health visitors, general practitioners or clinical medical officers, undertaken as part of a routine surveillance contact, had a mean uptake rate of 76.2%. Rates of referral from primary orthoptic screening programmes ranged from 4.1–10.6% of the screened population, with no differences between the various health professional groups.

In five studies of orthoptic screening programmes, the positive predictive value, (the percentage of those referred who are true positives) varied from 47–66%.[47, 51–53, 55] Positive predictive values of over 90% were achieved where the definition of a positive case was more broad.[48, 49, 54] In programmes run by health visitors or clinical medical officers, the positive predictive value was much more variable, ranging from 14–62%.[47, 49, 51, 80, 81] In other words, orthoptists are generally better at identifying these problems than doctors or health visitors. A significant number of areas use orthoptists (usually on a separate occasion) to test for visual problems around 3–4 years of age.

E.3 Interventions for vision problems: The treatments for amblyopia include patching the non-amblyopic eye and spectacle correction of associated refractive error, and surgery to correct squints (Table 7). Five prospective RCTs of treatment and six non-RCTs were found. None were specifically relevant to this age group and in no study was the treatment compared to an untreated control group, and thus the absolute effects of treatment are not known.

Three of the RCTs compared the effect of the CAM, (a vision stimulator grating) with conventional orthoptic treatment and showed no significant advantage.[84-86] One small RCT showed that adding the drug levodopa/carbidopa to orthoptic treatment for amblyopia improved visual acuity and contrast sensitivity. However at one month the intervention group had regressed slightly and the control group had not maintained improvement.[87] This latter finding is supported by a controlled study comparing different occlusion regimes, in which 33% of those with improved acuity after treatment showed some deterioration after 3 months.[88] Drugs and CAM are now rarely used in the UK.

Five controlled trials compared different approaches to amblyopia treatment.[88–92] All of these have methodological flaws which limit the value of their findings. Overall, whilst there is evidence that the vision of children with amblyopia improves with treatment,[84–92] these improvements may not be sustained.[84, 86–88]

Seven studies evaluating screening programmes reported improvements in visual acuity of two or more Snellen lines in 50–80% of children who were treated for amblyopia following screening.[47, 48, 50, 53, 55, 56, 93] However, as none of these have a comparison group of untreated children, it is difficult to assess the degree to which these changes are attributable to treatment. None of the studies assessed long-term outcomes of treatment, evaluated treatment in terms of disability or other patient-perceived outcomes. In addition, none of the studies assessed the potential negative impact of orthoptic treatment (such as patching) on children or their families, which has been suggested by recent qualitative work.[94]

An RCT[95] and a non-RCT[96] found that the use of pre-operative prism correction improved the outcome of squint surgery. However, these trials only included patients with obvious squints. No controlled studies of treatment for latent or micro-squints were found. Spectacles are a highly effective way of correcting refractive errors that requires no evaluation in older children. However, the treatment of refractive error in the absence of amblyopia or manifest squint is of unproven benefit and may even cause harm by inhibiting the normal refractive development of the eye (emmetropisation).[97]

Table 7 Treatments for visual problems identified at pre-school screen

- **Amblyopia:** intermittent occlusion of the non-amblyopic eye with a patch
- **Intermittent squints:** followed up and may be treated with surgery if they deteriorate
- **Latent squints with hypermetropia** (long sighted): often spectacle correction only
- **Microsquints and latent squints without hypermetropia:** not treated
- **Refractive errors:** left untreated or corrected by spectacles depending on severity and whether associated with amblyopia

F. Implications

This bulletin has summarised a range of important new research on three of the component parts of the child health surveillance programme. The three individual screening tests must be seen in the context of an overall child health programme which, as well as screening for specific health problems, also provides other health care, advice and support for families of young children. These individual screening programmes should, therefore, not be seen in isolation.

F.1 Hearing screening: Current services are seen by parents and professionals alike as poorly co-ordinated and fragmented.[5] As many as 200 of the 840 children per year born with significant hearing impairment may not be identified until after 3½ years of age. On the grounds of equity, responsiveness and cost-effectiveness, the transition from universal HVDT to universal neonatal hearing screening, in combination with targeted Infant Distraction Tests, is considered the best value for money. Some health authorities will be able to free some resources in moving from HVDT to universal neonatal hearing screening, as well as improve the service.

These results are currently being considered by the National Screening Committee in conjunction with plans for implementation, training and quality assurance. This should include quality markers such as initial coverage, sensitivity for congenital hearing impairment, and a maximum false-positive rate, and indicate relevant data to be collected. There will be a need for development and co-ordination of audiological follow-up services and the ongoing audiological and educational care of pre-school and school-aged hearing-impaired children, many of whom may have other and/or complex needs.[10]

F.2 Speech and language delay: There are insufficient data available to recommend the introduction of *population screening* for early speech and language delay because there is not yet adequate agreement as to which children will not progress *unless* they are given intervention and on the grounds that the current screening measures themselves have yet to be shown to have adequate predictive validity.

Nonetheless, early primary speech and language delay should remain a cause for concern. This is because of the problems it may pose for the individual child, the concern it causes parents, the fact it may serve as a litmus test for other problems which commonly accompany it such as cognitive impairment, behaviour and conduct disorders, and because of the implications that it may have for literacy and socialisation in school. However, further refinement of screening measures, with accompanying research, is needed before universal screening is recommended. There is also a case for the evaluation of primary prevention programmes aimed at reducing the risk of speech and language delay. Research should examine interventions which encourage parents to read with their children (e.g. Bookstart) and teach parents to listen to and respond appropriately to their child's communication attempts.

F.3 Pre-school vision screening: Amblyopia can cause a significant reduction in visual acuity, as measured by the Snellen test, but this may not be the best outcome measure. Equally, the physical, psychological and social implications of reduced visual acuity in one eye are not well understood. Thus it is not clear that amblyopia should be seen as the cause of significant disability or handicap. No study has addressed adequately the possible negative aspects of amblyopia treatment. Further research is needed to ascertain both the importance of this condition and the most effective and acceptable treatment.

Pre-school screening for refractive errors and non-obvious squint, without associated amblyopia, does not seem to be justified since these conditions do not appear to be problematic by themselves and their treatment at an asymptomatic stage has not been shown to confer benefit. The fact that existing research fails to show that screening for, and treatment of, amblyopia are beneficial is not however proof that a screening and treatment programme confers no benefit. Research is needed to establish whether pre-school screening is of benefit. Pending further research, and the recommendations of the National Screening Committee, it would seem inappropriate to initiate new programmes, or extend or dismantle existing ones.

Given the current uncertainty over the potential benefits and harms of testing and some corrective measures, it is particularly important that professionals give adequate and accurate information to parents.

References

1. Hall D, Hill P, Elliman D. *The child surveillance handbook.* 2nd edn. Oxford: Radcliffe Medical Press, 1994.
2. Hall DMB. *Health for all children: a programme for child health surveillance; the report of the Joint Working Party on Child Health Surveillance.* 1st edn. Oxford: Oxford University Press, 1989.
3. Hall DMB. *Health for all children: a programme for child health surveillance: the report of the Joint Working Party on Child Health Surveillance.* 2nd edn. Oxford: Oxford University Press, 1992.
4. Hall DMB. *Health for all children. The report of the Joint Working Party on Child Health Surveillance.* 3rd edn. Oxford: Oxford University Press, 1996.
5. Davis A, Bamford J, Wilson I, et al. A critical review of the role of neonatal hearing screening in the detection of congenital hearing impairment. *Health Technol Assess* 1997;1(10).
6. Law J, Boyle J, Harris F, et al. *Screening for speech and language delay: a systematic review of the literature.* CRD Report No 12. University of York: NHS Centre for Reviews and Dissemination, 1998.

7. Snowdon SK, Stewart-Brown SL. *Preschool vision screening: results of a systematic review.* CRD Report No. 9. University of York: NHS Centre for Reviews and Dissemination, 1997.
8. Wilson JMG, Jungner G. *Principles and practice of screening for disease.* Geneva: World Health Organisation, 1968.
9. Cochrane A, Holland W. Validation of screening procedures. *Br Med Bull* 1971;27:3–8.
10. Fortnum H, Davis A. Epidemiology of permanent childhood hearing impairment in Trent Region 1985–1993. *Br J Audiol* 1997;31:409–46.
11. Hunter MF, Kimm L, Cafarelli Dees D, et al. Feasibility of otoacoustic emission detection followed by ABR as a universal neonatal screening test for hearing impairment. *Br J Audiol* 1994;28:47–51.
12. Watkin PM. Neonatal otoacoustic emission screening and the identification of deafness. *Arch Dis Child* 1996;74:F16–F25.
13. Watkin PM. Optimising the specificity of a neonatal otoacoustic emission screen. Unpublished report, 1996.
14. Watkin PM. Outcomes of neonatal screening for hearing loss by otoacoustic emissions. *Arch Dis Child* 1996;75:F158–68.
15. Downs MP. Universal newborn hearing screening – the Colorado story. *Int J Pediatr Otorhinolaryngol* 1995;32:257–9.
16. Yoshinaga-Itano C, Sedey A, Apuzzo M, et al. The effect of early identification on the development of deaf and hard-of-hearing infants and toddlers. *Paediatrics* 1998; in press.
17. Markides A. Age at fitting of hearing aids and speech intelligibility. *Br J Audiol* 1986;20:165–7.
18. Eilers RE, Oller DK. Infant vocalisations and the early diagnosis of severe hearing impairment. *J Pediatr* 1994;124:199–203.
19. Ramkalawan TW, Davis AC. The effects of hearing loss and age of intervention on some language metrics in young hearing-impaired children. *Br J Audiol* 1992;26:97–107.
20. Ramkalawan TW. Factors that influence the language and communication of hearing impaired children. Unpublished. PhD thesis, 1997.
21. Musselman CR, Wilson AK, Lindsay PH. Effects of early intervention on hearing impaired children. *Except Child* 1988;55:222–8.
22. Stevens JC, Hall DMB, Davis A, et al. A survey of the costs of hearing screening in the first year of life in England and Wales. *Arch Dis Child* 1998;78:14–19.
23. Drillien C, Drummond M. *Developmental screening and the child with special needs.* London: Heinemann, 1983.
24. Jowett S, Evans C. *Speech and language therapy services for children.* Slough: NFER, 1996.
25. Reid J, Millar S, Tait L, et al. *Pupils with special education needs: the role of speech and language therapists.* Edinburgh: SCER, 1996.
26. Ward S, Birkett D. *The Ward Infant Language Screening Test, assessment, acceleration and remediation.* Manchester: Manchester Health Care Trust, 1994.
27. Almost D, Rosenbaum P. Effectiveness of speech intervention for phonological disorders: a randomised controlled trial. Unpublished, 1997.
28. Conant S, Budoff M, Hecht B, et al. Language intervention: a pragmatic approach. *J Autism Dev Disord* 1984;14:301–17.
29. Fey ME, Cleave PL, Long SH, et al. Two approaches to the facilitation of grammar in children with language impairment: an experimental evaluation. *J Speech Hear Res* 1993;36:141–57.
30. Fey ME, Cleave PL, Ravida AI, et al. Effects of grammar facilitation on the phonological performance of children with speech and language impairments. *J Speech Hear Res* 1994;37:594–607.
31. Gibbard D. Parental-based intervention with pre-school language-delayed children. *Eur J Disord Commun* 1994;29:131–50.
32. Girolametto L, Pearce PS, Weitzman E. Interactive focused stimulation for toddlers with expressive vocabulary delays. *J Speech Hear Res* 1996;39:1274–83.
33. Girolametto L, Pearce PS, Weitzman E. The effects of focused stimulation for promoting vocabulary in young children with delays: a pilot study. *J Child Commun Dev* 1995;17:39–49.
34. Lancaster G. The effectiveness of parent administered input training for children with phonological disorders. MSc Thesis. London: City University, 1991.
35. Matheny N, Panagos JM. Comparing the effects of articulation and syntax programs on syntax and articulation improvement. *Lang Speech Hear Serv in School* 1978;9:57–61.
36. McDade A, McCartan PA. Partnership with parents: a pilot study. Unpublished, 1996.
37. Reid J, Donaldson ML, Howell J, et al. The effectiveness of therapy for child phonological disorder. The Metaphon approach. In: Aldridge M (ed.). *Child Language.* Clevedon, Avon: Multilingual Matters, 1996:165–75.
38. Schwartz RG, Chapman K, Terrell BY, et al. Facilitating word combination in language-impaired children through discourse structure. *J Speech Hear Disord* 1985;50:31–9.
39. Shelton RL, Johnson AF, Ruscello DM, et al. Assessment of parent-administered listening training for preschool children with articulation deficits. *J Speech Hear Disord* 1978;43:242–54.
40. Stevenson P, Bax M, Stevenson J. The evaluation of home-based speech therapy for language delayed preschool children in an inner city area. *Br J Disord Commun* 1982;17:141–8.
41. Ward S. Validation of a treatment method. In the proceedings of the 2nd Conference of the Comite Permanente de Liaison des Othophonistes-Logopedes del'UE [CPLOL], Antwerp, 1994.
42. Warrick N, Rubin H, Rowe-Walsh S. Phoneme awareness in language-delayed children: comparative studies and interventions. *Ann Dyslexia* 1993;43:153–73.
43. Whitehurst GJ, Fischel JE, Lonigan CJ, et al. Treatment or early expressive language delay: if, when, and how. *Top Lang Disord* 1991;11:55–68.
44. Wilcox MJ, Leonard LB. Experimental acquisition of Wh- questions in language-disordered children. *J Speech Hear Res* 1978;21:220–39.
45. Zwitman DH, Sonderman JC. A syntax program designed to present base linguistic structures to language-disordered children. *J Commun Disord* 1979;12:323–35.
46. Barnett WS, Escobar CM, Ravsten MT. Parent and clinic early intervention for children with language handicaps: a cost effectiveness analysis. *J Division Early Child* 1988;12:290–8.
47. Bolger P, Stewart Brown S, Newcombe E, et al. Vision screening in preschool children: comparison of orthoptists and clinical medical officers as primary screeners. *BMJ* 1991;303:1291–4.
48. Beardsell R. Orthoptic visual screening at 3.5 years by Huntingdon Health Authority. *Br Orthop J* 1989;46:7–13.
49. Edwards R. Orthoptists as pre-school screeners: a 2 year study. *Br Orthop J* 1989;46:14–19.

50. Ingram R, Holland W, Walker C, et al. Screening for visual defects in preschool children. *Br J Ophthalmol* 1986;70:16–21.
51. Jarvis S, Tamhne R, Thompson L, et al. Preschool vision screening. *Arch Dis Child* 1990;65:288–94.
52. Milne C. An evaluation of cases referred to hospital by the Newcastle preschool orthoptic service. *Br Orthop J* 1994;51:1–5.
53. Newman D, Hitchcock A, McCarthy H, et al. Preschool vision screening: outcome of children referred to the hospital eye service. *Br J Ophthalmol* 1996;80:1077–82.
54. Wormald R. Preschool vision screening in Cornwall: performance indicators of community orthoptists. *Arch Dis Child* 1991;66:917–20.
55. Williamson T, Andrews R, Dutton G, et al. Assessment of an inner city visual screening programme for preschool children. *Br J Ophthalmol* 1995;79:1068–73.
56. Bray L, Clarke M, Jarvis S, et al. Preschool vision screening: a prospective comparative evaluation. *Eye* 1996;10:714–18.
57. Good W, da Sa L, Lyons C, et al. Monocular visual outcome in untreated early onset esotropia. *Br J Ophthalmol* 1993;77:492–4.
58. Aurell E, Norrsell K. A longitudinal study of children with a family history of strabismus. *Br J Ophthalmol* 1990;74:589–94.
59. Hard A, Williams P, Sjostrand J. Do we have optimal screening limits in Sweden for vision testing at the age of 4 years? *Acta Ophthalmol Scand* 1995;73:483–5.
60. Stewart-Brown S, Haslum M, Butler N. Educational attainment of 10 year old children with treated and untreated visual defects. *Dev Med Child Neurol* 1985;27:504–13.
61. Teasdale T, Fuchs J, Goldschmidt E. Degree of myopia in relation to intelligence and educational level. *Lancet* 1988:1351–54.
62. McManus I, Mascie-Taylor C. Biosocial correlates of cognitive abilities. *J Biosoc Sci* 1983;15:289–306.
63. Peckham C, Gardiner P, Goldstein H. Acquired myopia in 11 year old children. *BMJ* 1977;1:542–5.
64. Grosvenor T. Are visual anomalies related to reading ability? *J Am Optom Assoc* 1977;48:510–17.
65. Simons H, Gassler P. Vision anomalies and reading skill: a meta-analysis of the literature. *Am J Optom Physiolog Optics* 1988;65:893–904.
66. Bishop D, Jancey C, Steel A. Orthoptic status and reading disability. *Cortex* 1979;15:659–66.
67. Hall P. The relationship between ocular functions and reading achievement. *J Pediatr Ophthalmol Strabismus* 1991;28:17–9.
68. Alberman E, Butler N, Gardiner P. Children with squints – a handicapped group? *Practitioner* 1971;206:501–6.
69. Bax M, Whitmore K. Neurodevelopmental screening in the school-entrant medical examination. *Lancet* 1973;825:368–70.
70. McGee R, Williams S, Simpson A, et al. Stereoscopic vision and motor ability in a large sample of seven year old children. *J Hum Movement Studies* 1991;13:343–52.
71. Fielder A, Moseley M. Does stereopsis matter in humans? *Eye* 1996;10:233–8.
72. Jones R, Lee D. Why two eyes are better than one: the two views of binocular vision. *J Exp Psychol, Hum Percept Perform* 1981;7:30–40.
73. Servos P, Goodale M, Jakobson L. The role of binocular vision in prehension: kinematic analysis. *Vision Res* 1992;32:1513–21.
74. Kani W. *Human amblyopia and its perceptual consequences*. Durham: University of Durham, 1980.
75. Williams C, Harvey I, Frankel S, et al. Preschool vision screening – results of a randomised controlled trial. *Invest Ophthalmol Vis Sci* 1996;37:111.
76. Nolan J. Data on preschool vision screening in South Birmingham, April 1995–March 1996. Personal communication, 1996.
77. Allen J, Bose B. An audit of preschool vision screening. *Arch Dis Child* 1993;67:1292–93.
78. Cameron H, Cameron M. Visual screening of pre-school children. *BMJ* 1978:1693–94.
79. Gallaher R. *Community orthoptic visual screening: first year report, 1994–1995*. South Buckinghamshire NHS Trust, 1995.
80. Kohler L, Stigmar G. Vision screening of four-year-old children. *Acta Paediatr Scand* 1973;62:17–27.
81. Kohler L, Stigmar G. Visual disorders in 7-year-old children with and without previous vision screening. *Acta Paediatr Scand* 1978;67:373–7.
82. Seng C, Curson J. *Study of the outcomes of referrals from the orthoptic vision screening programme*. Luton: Bedfordshire Health, 1991.
83. James J. Data on preschool vision screening in Highworth, Swindon, 1983–1991. Personal communication, 1996.
84. Keith C, Howell E, Mitchell D, et al. Clinical trial of the use of rotating grating patterns in the treatment of amblyopia. *Br J Ophthalmol* 1980;64:597–606.
85. Nyman K, Singh G, Rydberg A, et al. Controlled study comparing CAM treatment with occlusion therapy. *Br J Ophthalmol* 1983;67:178–80.
86. Tytla M, Labow-Daily L. Evaluation of the CAM treatment for amblyopia: a controlled study. *Invest Ophthalmol Vis Sci* 1981;20:400–6.
87. Leguire L, Walson P, Rogers G, et al. Longitudinal study of levodopa/carbidopa for childhood amblyopia. *J Pediatr Ophthalmol Strabismus* 1993;30:354–60.
88. Terrell Doba A. Cambridge stimulator treatment for amblyopia. An evaluation of 80 consecutive cases treated by this method. *Austral J Ophthalmol* 1981;9:121–7.
89. Lennerstrand G, Samuelsson B. Amblyopia in 4-year-old children treated with grating stimulation and full-time occlusion – a comparative study. *Br J Ophthalmol* 1983;67:181–90.
90. Malik S, Gupta A, Grover V. Occlusion therapy in amblyopia with eccentric fixation. *Br J Ophthalmol* 1970;54:41–5.
91. Sullivan G, Fallowfield L. A controlled test for the CAM treatment for amblyopia. *Br Orthopt J* 1980;37:47–55.
92. Veronneau Troutman S, Dayanoff S, Stohler T, et al. Conventional occlusion vs pleoptics in the treatment of amblyopia. *Am J Ophthalmol* 1974;78:117–20.
93. Fathy V, Elton P. Orthoptic screening for three- and four-year olds. *Public Health* 1993;107:19–23.
94. Snowdon S, Stewart-Brown S. *Amblyopia and disability: a qualitative study*. Oxford: Health Services Research Unit, University of Oxford, 1997.
95. Group PASR. Efficacy of prism adaptation in the surgical management of acquired esotropia. *Arch Ophthalmol* 1990;108:1248–56.
96. Ohtsuki H, Hasebe S, Tadokoro Y, et al. Preoperative prism correction in patients with acquired esotropia. *Graefes Arch Clin Exp Ophthalmol* 1993;231:71–5.
97. Troilo D. Neonatal eye growth and emmetropisation – a literature review. *Eye* 1991;6:154–60.

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