

Vision screening – referral to discharge. Outcomes from a routine vision screening programme

MOHAMMED A. MAQSUD MMedSci BSc (Hons) AND
SANDRA D. MEDFORTH DBO Orthoptics

Orthoptic Department, Hull Royal Infirmary, Hull

Abstract

Aims: To investigate a local vision screening programme, the conditions identified at routine vision screening and the visual acuity outcomes of children referred.

Methods: A retrospective analysis of children who underwent vision screening between 1 September 2005 and 31 August 2006 was undertaken. The screening programme included an assessment of unocular vision, cover test, ocular motility, binocular reflex and stereo-acuity. All children referred had their hospital case notes reviewed and data on final corrected visual acuity, refractive error and follow-up period collected.

Results: Of 2468 children offered vision screening 2240 gave consent and were tested (90.8% coverage), 309 (13.8%) children were referred, and 264 (85.4%) patients attended of whom 33 (12.5%) were false positive referrals. The vision screening programme had a positive predictive value of 87.5%. Corrected visual acuity was 0.200 logMAR or better in each eye in 89.1% of patients, 64.0% required only optimum refractive correction as their sole treatment and 10.2% required a period of occlusion therapy.

Conclusions: Orthoptic-based screening programmes provide an efficient vision screening mechanism, achieving high coverage, and low re-test and false positive levels. Vision screening has been shown to identify a variety of conditions which had until that point gone unnoticed. Those referred show excellent visual acuity outcomes.

Key words: Amblyopia, Outcome, Vision screening

Introduction

Vision screening has been carried out in the UK for many years by a number of different professions.¹ Screening is a risk reduction process for target conditions; there will always be some risk of false positive and false negative referrals due to the sensitivity and specificity of tests, and as such screening must be measured against the principle of ‘doing more good than

harm’.² Therefore there needs to be not only monitoring of the specificity and sensitivity of screening programmes but also a measure of the outcomes of those that undergo the screening process.²

Sporadic articles have been published assessing the outcomes of children who have undergone vision screening, but much of the focus has been placed on individuals with unilateral amblyopia.^{3–5} Few articles exist in which the outcomes of all those referred by the screening programme were analysed.^{5–7} Carlton and Czoski-Murray state for a vision screening programme to be cost-effective it first has to show that it is clinically effective.⁸ The local screening programme was commissioned on the basis of the *Health for All Children* report and the recommendations of the Child Health Promotion Programme (CHPP).⁹ The recommendations state the target conditions to be identified are amblyopia, refractive error, and strabismus which was not cosmetically obvious.⁹ This study investigated a local orthoptic screening programme against these measures.

Methods

This study was a retrospective analysis of hospital records of children referred from routine vision screening between 1 September 2005 and 31 August 2006. All children were invited to routine vision screening to be assessed by an orthoptist. To be included informed consent was required from the parent or guardian. Orthoptic examination included measurement of vision in each eye to threshold using the Keeler Crowded logMAR test or the Crowded Kay’s Picture test (pass criteria 0.200 or 0.100 logMAR respectively); cover test carried out for near and distance fixation; assessment of ocular motility; convergence; assessment of binocularity using a 20^Δ prism reflex test; and stereo-acuity measured to threshold using the Frisby Stereotest. Any child who did not meet the visual acuity standard or was found to show a difference of vision of 1 logMAR line required referral, as did any child with a manifest strabismus. Significant latent strabismus (>10^Δ), ocular motility deficits, unsatisfactory binocular status (UBS) such as poor convergence or poor control of a phoria were referred at the discretion of the examiner. Testing was carried out between the ages of 4 and 5 years, predominantly in a school setting; some children were seen at a local health centre. All testing was carried out by one of the Department’s 9 registered orthoptists, all of whom had at least 3 years’ experience. The outcomes

Correspondence and offprint requests to: Mohammed Maqsd, Orthoptic Department, Clinical Skills Building, Fountain Street, Anlaby Road, Hull Royal Infirmary, Hull, East Yorkshire HU3 2JZ. e-mail: mohammed.maqsd@hey.nhs.uk

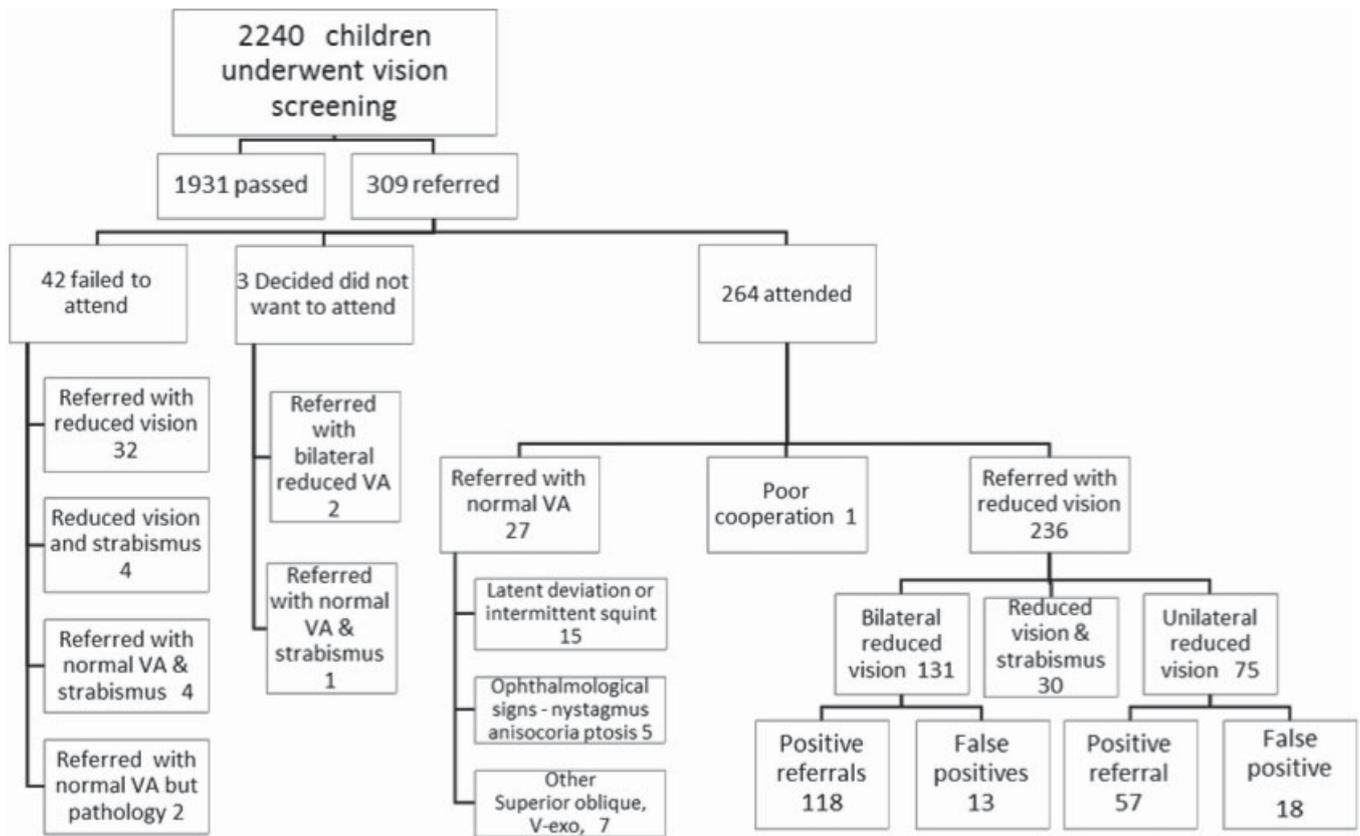


Fig. 1. Outcomes from the vision screening programme.

of vision screening were: (1) pass, (2) retest, (3) refer. Any child who failed to reach the pass criteria was referred to the local paediatric ophthalmologist or the Orthoptic Led Service (OLS) as per local protocol. Those with reduced visual acuity only were seen under the OLS and had a cycloplegic refraction and fundus and media check carried out by an optometrist rather than an ophthalmologist. No set protocols exist within the Department for prescribing glasses and so were prescribed at the examiner's discretion. All examiners (ophthalmologist or optometrist) had more than 5 years of clinical experience refracting children and working within the paediatric ophthalmology service. Any child not prescribed glasses where referral was on the basis of reduced vision was termed a false positive referral. Any child referred due to presence of significant phoria or UBS as described, due to poor convergence, poor fusional ability or stereo-acuity if confirmed was termed a true positive.

Trust approval was gained for the study. Participants referred to the Hospital Eye Service (HES) had their hospital notes requested and a data collection form for each participant was completed collecting information on visual acuity; refractive error; follow-up period; presence of strabismus; and whether the participant underwent occlusion therapy. The first cycloplegic refraction result was used to inform the study and visual acuity outcome was defined as the final recorded visual acuity. Local protocol dictated discharge from the HES when a child achieved good visual acuity and was

thought able to manage a basic subjective refraction. The age range tends to be between 6.50 and 7.00 years. Outcome vision was measured using the Keeler Crowded logMAR test.

Results

The outcomes of the screening programme are shown in Fig. 1. Consent was received for 2240 children who underwent routine vision screening – from 2468, giving coverage of 90.8%. Of these, 2095 children were seen in the school setting and 145 in a local health centre. Of the children screened 13.8 % (309) were referred; the vast majority were assessed within the school environment, with 88.3% referred directly from an assessment which took place at school. Of those who were referred, 50.8% were male and 49.2% female; 51.1% had had their visual acuity tested using the Keeler Crowded logMAR test and 48.5% using the Crowded Kay's Picture test. Of the 309 children referred, 3 (1%) parents declined the referral, 42 (13.6%) failed to attend the HES having been invited to attend. Table 1 shows a synopsis of the reason children were referred by the screening service. Fifty-four children were referred either solely or partly due to concern over a significant latent or manifest strabismus. Thirty-four of the 54 also had reduced vision in one or both eyes; 20 had normal visual acuity, 6 with a significant esodeviation, 14 with a significant exodeviation. Only 1 child was referred due to a lack of cooperation.

Visual acuity at referral ranged from -0.100 to 0.875

Table 1. The reasons for the referral

Reason for referral	No. (<i>n</i> = 309)	%
Reduced VA in one eye	81	26.2
Reduced VA in one eye and strabismus	12	3.9
Reduced VA in both eyes	159	51.5
Reduced VA in both eyes and strabismus	22	7.1
Strabismus with normal VA		
Esophoria	3	1.0
Esotropia (constant or intermittent)	3	1.0
Exophoria	6	1.9
Exotropia (constant or intermittent)	8	2.6
Other	14	4.5
Not cooperative	1	0.3

Table 2. Visual acuity at referral

Visual acuity at referral ^a	Better seeing eye		Poorer seeing eye	
	No. (<i>n</i> = 309)	%	No. (<i>n</i> = 309)	%
Better than 0.200	171	55.3	54	15.6
0.225–0.300	85	27.4	83	19.5
0.325–0.400	36	11.7	74	28.3
0.425–0.500	7	2.3	30	11.4
0.525–0.600	4	1.3	21	8.5
0.625–0.700	3	1.0	17	5.2
0.725–0.800	2	0.7	11	3.6
0.825–0.900	1	0.3	9	3.9
0.925 or worse	0	0	10	3.6

^aKeeler Crowded or Crowded Kay's Picture test.

logMAR in the better seeing eye and -0.100 to 1.400 logMAR in the poorer eye; 53 children had worse than 0.300 logMAR in their better eye at the time of referral (Table 2). The OLS was responsible for 82.5% of patients referred from the vision screening programme. Table 3 shows an analysis of the treatment required by patients and the outcomes of the screening service. 74.6% (197) of patients required spectacles; 12.5% (33) were false positives and 11.7% (31) required no formal treatment for the condition they were referred with other than advice. Appropriate refractive correction was the sole treatment for 64.0% (169) of patients; occlusion was only required in 27 (10.2%) cases; 98.8% of patients achieved at least 0.200 logMAR in one eye (Figs. 2, 3) and 89.1% achieved at least 0.200 logMAR in each eye.

Follow-up for patients who attended at least one appointment ranged from 8 to 168 weeks, median 106 weeks.

No glasses were prescribed in 67 cases; 33 of these children were referred due to suspected reduced vision in one or both eyes and were false positive referrals. Of the occlusion cases 6 had strabismus; 12 had anisometropia; 6 had strabismus and anisometropia; and 3 had no discernible amblyogenic factor. Thirty-four children were referred with visual acuity which achieved the pass criteria set, of whom 27 attended at least one appointment. Fifteen of these were referred with significant exophoria or intermittent exotropia; of these, 2 ultimately opted for surgery. One child was referred with significant superior oblique palsy which required surgery. Three children were referred with significant esophoria or poor binocular status and required refractive correction; a further 3 children were referred as they were slow with their visual acuity and again required

Table 3. Treatment given and the outcomes achieved

	No. (<i>n</i> = 264)	%
<i>Initial outcome</i>		
No glasses prescribed	67	25.4
Low error	9	3.4
Hyperopia ≥ 1.50 D	107	40.5
Myopia > -0.50	10	3.8
Astigmatism ≥ 1.00 D	71	26.9
Hyperopic	42	15.9
Myopic	1	0.4
Mixed	28	10.6
Anisometropia ≥ 1.00 D	55	21.0
Spherical		
Hyperopic	40	72.7
Hyperopic and astigmatic	6	10.9
Myopic	2	3.6
Myopic and astigmatic	4	7.3
Astigmatic	3	5.5
<i>Treatment</i>		
Glasses only	169	64.0
Glasses and occlusion	26	9.8
Occlusion only	1	0.4
Functional squint correction	2	0.8
Glasses and cosmetic squint correction	2	0.8
Diagnosis confirmed no formal treatment	31	11.7
False-positive referral	33	12.5
<i>Attendance</i>		
Completed treatment to discharge	166	62.9
Attended >1 year before FTA	47	17.8
Attended <1 year before FTA	25	9.5
Only attended first appointment	26	9.8

refractive correction. One child was referred with very fine manifest nystagmus and was given advice on abnormal head posture and referred on to the Sensory Impairment team. One child was referred with ptosis and a further 3 with anisocoria.

Discussion

The screening programme achieved coverage of over 90% in the local area, which compares well with similar programmes.^{6,7} The coverage rate shows the benefits of testing the 4- to 5-year-old age group within the school environment. The positive predictive value (PPV) for the screening programme was 87.5% (33 false positive referrals); unfortunately there was not enough information to determine the false negative value of the screening programme.

Table 4 shows how this study compares with other vision screening programmes. The false positive rate of the screening programme was similar to that of Hu *et al.*⁶ but significantly lower than the Newman *et al.*⁷ study. Both studies were orthoptic-based screening programmes carrying out similar tests, the only difference being the age at which children were assessed. The Newman *et al.* study had more stringent criteria when defining false positive referrals, which may explain their higher false positive rate. When comparing the PPV of orthoptic-based screening programmes, as in this study, against figures for programmes carried out by a school nurse or clinical medical officer (which range between 40% and 60%), the efficiency of an orthoptic-based programme is clear.¹ The study found a re-test rate of 5.3%. Hu *et al.* do not provide a figure; however, when compared with a school nurse screening programme it is

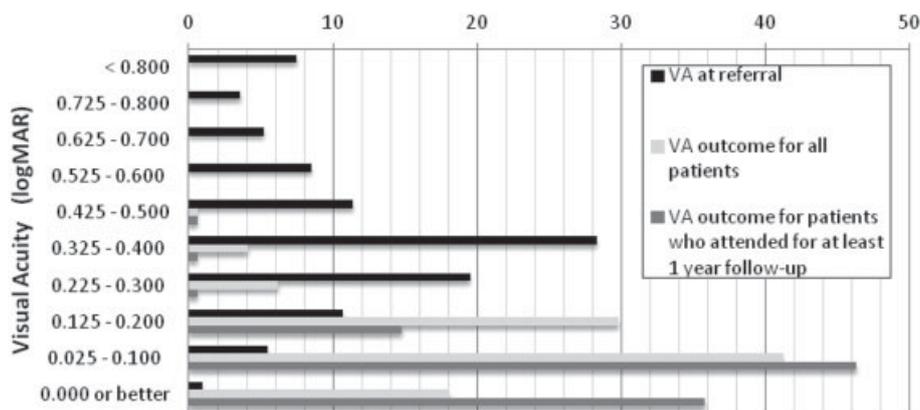


Fig. 2. Visual acuity in the poorer seeing eye at referral and the final visual acuity measured following treatment.

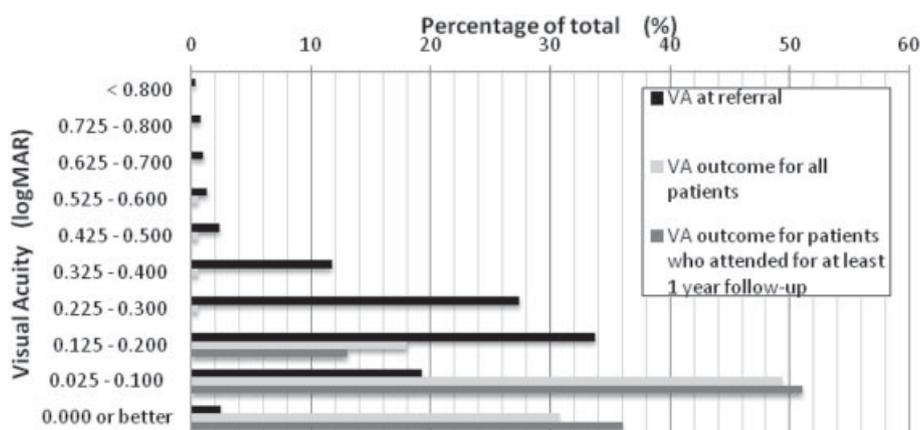


Fig. 3. Visual acuity in the better seeing eye at referral and the final visual acuity measured following treatment.

Table 4. How this study compares with other vision screening programmes

	This study	Hu <i>et al.</i> (2012) ⁶	Newman <i>et al.</i> (1996) ⁷	Sheffield PCT (2011) ¹⁰
Age screening carried out (years)	4–5	3–4	3.5	4–5
Tester	Orthoptist	Orthoptist	Orthoptist	School nurse
Coverage (%)	2240 (91)	2830 (78)	6794 (79)	5608 (97)
Re-test rate (%)	119 (5.3)	–	–	967 (17)
Referral rate (%)	309 (13.8)	413 (17.0)	348 (5.1)	508 (9.1)
<i>Outcomes of referral</i>				
Refractive error only	169 (64)	117 (44)	100 (33)	–
Amblyopia	27 (10)	41 (16)	91 (30)	–
Strabismus without amblyopia	22 (5.2)	9 (3)	40 (13)	–
False positives	33 (13)	35 (13)	61 (20)	–
Other	13 (7.8)	62 (24)	12 (3.5)	–
Total	264 (100)	264 (100)	304 (100)	–

found to be much lower: 5.3% compared with 17.3%.¹⁰ This study indicates an orthoptic-based programme would potentially achieve a significantly lower re-test rate compared with a school nurse/technician-based programme. Technician-based screening programmes have been promoted as a potentially more cost-effective approach to carrying out vision screening.¹² However, the potential additional costs to these programmes due to increased re-test rates and lower PPV need to be taken into consideration. Without doubt an orthoptic-based programme will have a higher capital expenditure, but

may recoup some of these costs in efficiency savings. It is difficult to extrapolate this information as there is little published evidence on school nurse/technician-based screening to allow a comparison and is an area that needs further work.

There has been a discussion within the orthoptic profession that vision screening involves too many tests, with the concern that this may place patients and parents under significant stress and anxiety which may not be deemed acceptable. The findings from this study indicate these concerns may be overstated, given the coverage of

the programme and that only one child failed to complete the tests. These statements are often made in support of technician-based screening; however, the study indicates this view may fail to acknowledge the potential anxiety and stress created by the additional re-tests and lower PPV of a technician-based approach.

The benefit of an orthoptic screening programme is not limited to financial efficiency and nor should this be the only perspective by which it is assessed. An orthoptic vision screening programme is the 'gold-standard', as shown by its excellent PPV and low re-test rates, and as such provides an excellent quality of service to children and parents.^{1,11}

A number of children were referred to the HES due to incidental findings such as ptosis, nystagmus, anisocoria, or other orthoptic problems such as unsatisfactory binocular status ($n=14$). Though these are not target conditions for vision screening, and do not justify the use of orthoptists for screening, it does show the potential added value of using orthoptists.

Fifty-four children were referred over concern due to a significant latent or a manifest strabismus, 20 of whom had normal vision. There is a view that a problematic squint would have been detected by either the parent or the health visitor, and if it has not then it can be assumed that it has not caused a problem and by implication strabismus assessment need not be included as part of a routine vision screening assessment.¹² This view is controversial both within and outside the orthoptic profession. Furthermore this approach may not be acceptable to the general public and to commissioners. This is an area that needs to be considered, especially with the greater role of the public in commissioning care.¹³ The number of children who were referred from screening with strabismus would suggest parents and health visitors are not efficient at detecting strabismus, as demonstrated by Rosner and Rosner,¹⁴ and should not be relied upon. Ignoring this would mean that we ignore the potential detriment to a child's development and learning which has been shown by the work of Evans and Drasdo¹⁵ and Menon *et al.*¹⁶ and the potential psychological detriment strabismus can cause. There is an assumption that all children have equal access to care; however, research has shown significant differences exist between different socio-economic groups in terms of knowing how best to access care.¹⁷ Vision screening provides an opportunity to ensure that all children have equal access and therefore equal opportunity.

The current UK guidelines recommend screening children between the ages of 4 and 5 years. Clarke *et al.* found that delaying the start of treatment until age 5 years did not influence outcomes.⁴ The PEDIG ATS study, which compared the long-term vision outcomes of amblyopia in those treated before and after 5 years of age, found those treated earlier achieved better outcomes.¹⁸ The visual acuity outcomes from the current study were compared with those in the Hu *et al.* study which investigated a vision screening programme assessing 3- to 4-year-olds.⁶ They reported 54.7% of children achieved 6/6 or better; this study found that 18.1% achieved 0.000 logMAR (6/6) or better in each eye and 31.1% achieved this level in at least one eye. Outcomes from this study thus fall below those reported

by Hu *et al.*, which may be due to a number of factors.⁶ Firstly it is not clear whether Hu *et al.* reported a measure of visual acuity in the better eye or in both eyes; secondly it is unclear which visual acuity test was used, making comparison between the two studies difficult.⁶ If a standard of at least 0.050 (6/6pt) is used, 35.9% of patients achieved this level in each eye and 55.0% achieved this level in at least one eye, which is much more comparable to the Hu *et al.* study.⁶ This conformity between the two studies is seen further when comparing the percentage of children who achieved at least 0.200 logMAR (89.1% and 87.2%, respectively).⁶ As in the Hu *et al.* study those with greater than 1 year follow-up achieved better visual acuity levels. It should be pointed out that some of the improvement in visual acuity may be secondary due to age and learning effects.¹ Furthermore in some patients there was change in test from initial referral to final outcome, as a significant proportion of patients were referred using the Crowded Kay's Picture test. This, however, should lead to an underestimation of visual acuity improvement as the Crowded Kay's Picture test can overestimate visual acuity compared with the Keeler Crowded logMAR test, especially where visual acuity is moderately reduced.¹⁹

Conclusions

This orthoptic-based screening programme provides an efficient vision screening mechanism, identifying a variety of conditions which had until that point gone unnoticed. This study screened children between 4 and 5 years of age, which allowed the programme to achieve excellent coverage. Those referred showed excellent visual acuity outcomes, comparable to those reported by Hu *et al.* who screened a younger age group.⁶ The study found a lower re-test rate and higher PPV compared with a school nurse based programme, which commissioners need to be aware of as it has cost implications.

The authors thank to Alexandra Lindstrom for her comments and Mr Jim Innes whose patients informed the study.

References

1. Carlton J, Kamon J, Czoski-Murray C, Smith K, Marr J. The clinical effectiveness and cost-effectiveness of screening programmes for amblyopia and strabismus in children up to the age of 4-5 years: a systematic review and economic evaluation. *Health Technol Assess* 2008; **12** (25). Available at: <http://www.ncbi.nlm.nih.gov/books/NBK56835/>
2. UK NSC. What is screening? 2012. Available at: <http://www.screening.nhs.uk/screening> [accessed 8 February 2013].
3. Taylor K, Powell C, Hatt SR, Stewart C. Interventions for unilateral and bilateral refractive amblyopia. *Cochrane Database Syst Rev* 2012. Available at: <http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD005137/full> [accessed 14 July 2013].
4. Clarke M, Wright C, Hrisos S, *et al.* Randomised controlled trial of treatment of unilateral visual impairment detected at preschool vision screening. *Br Med J* 2003; **28**: 422-428.
5. Williams C, Northstone K, Harrad R, *et al.* Amblyopia treatment outcomes after preschool screening v school entry screening: observational data from a prospective cohort study. *Br J Ophthalmol* 2003; **87**: 988-993. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1771818/>
6. Hu V, Starling A, Baynham S, *et al.* Accuracy of referrals from an orthoptic vision screening program for 3- to 4-year-olds. *J AAPOS* 2012; **16**: 49-52. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1793472/>
7. 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**: 1077-1082. Available at:

- http://www.researchgate.net/publication/14153060_Preschool_vision_screening_outcome_of_children_referred_to_the_hospital_eye_service
8. Carlton J, Czoski-Murray C. Screening for amblyopia and strabismus in children aged 4–5 years: where do we go from here? *Br Ir Orthopt J* 2009; **6**: 15–21.
 9. Hall D, Elliman D. *Health for All Children*. Oxford: Oxford University Press, 2003.
 10. Sheffield Primary Care Trust. Vision screening in children – NHS Sheffield. 2011. Available at: http://www.sheffield.nhs.uk/foi/resources/dl_1010/FOI-205-10.pdf [accessed 12 April 2013].
 11. Bolger P, Stewart-Brown S, Newcombe E, *et al*. Vision screening in preschool children: comparison of orthoptists and clinical medical officers as primary screeners. *Br Med J* 1991; **303**: 1291–1294. Available at: <http://www.bmj.com/content/bmj/303/6813/1291.full.pdf>
 12. Butcher C. Vision screening. *Br Ir Orthopt J* 2012; **9**: 80–81.
 13. Department of Health. The functions of Clinical Commissioning Groups: updated to reflect the final Health and Social Care Act 2012. Available at: <https://www.gov.uk/government/publications/the-functions-of-clinical-commissioning-groups-updates-to-reflect-the-final-health-and-social-act-2012> [accessed 6 April 2013].
 14. Rosner J, Rosner J. Parents as screeners for strabismus in their children. *J Vis Impair Blind* 1988; **82**: 193–194.
 15. Evans B, Drasdo N. Investigation of accommodation and binocular function in dyslexia. *Ophthalmic Physiol Optics* 2007; **14**: 5–19.
 16. Menon V, Saha J, Tandon R, *et al*. Study of the psychological aspects of strabismus. *J Pediatr Ophthalmol Strabismus* 2002; **39**: 203–208. Available at: [http://www.jaapos.org/article/S1091-8531\(07\)00444-2/fulltext](http://www.jaapos.org/article/S1091-8531(07)00444-2/fulltext)
 17. Gulliford M, Figueroa-Munoz J, Morgan M, *et al*. What does ‘access to health care’ mean? *Journal Health Service Res Policy* 2002; **7**: 186–188. Available at: <http://hsr.sagepub.com/content/7/3/186.long>
 18. Repka MX, Kraker RT, Beck RW, *et al*. A randomised trial of atropine vs patching for treatment of moderate amblyopia; follow-up at age 10 years. *Arch Ophthalmol* 2008; **126**: 1039–1044.
 19. Elliott MC, Firth AY. The logMAR Kay picture test and the logMAR acuity test: a comparative study. *Eye* 2009; **23**: 85–88.