

Eye Examination and Vision Screening in Infants, Children, and Young Adults

Committee on Practice and Ambulatory Medicine, Section on Ophthalmology

Vision screening and eye examination are vital for the detection of conditions that distort or suppress the normal visual image, which may lead to inadequate school performance or, at worst, blindness in children. Retinal abnormalities, cataracts, glaucoma, retinoblastoma, eye muscle imbalances, and systemic disease with ocular manifestations may all be identified by careful examination. Examination of the eyes can be performed at any age, beginning in the newborn period, and should be done at all well infant and well child visits. Vision screening should be performed for a child at the earliest age that is practical, because a small child rarely complains that one eye is not seeing properly. Conditions that interfere with vision are of extreme importance, because visual stimuli are critical to the development of normal vision. Normal visual development requires the brain to receive equally clear, focused images from both eyes simultaneously for visual pathways to develop properly.

Vision screening should be carried out as part of the regular plan for continuing care beginning at 3 years of age. Vision screening guidelines have been endorsed by the American Academy of Pediatrics (AAP), the American Association for Pediatric Ophthalmology and Strabismus (AAPOS), and the American Academy of Ophthalmology (AAO). To achieve the most accurate testing possible, the most sophisticated test that the child is capable of performing should be used (see "Appendix 1").¹

As with other specialty areas, it is important for the pediatrician to establish contact with an ophthalmologist who is experienced in treating children's eye problems and who practices in the same geographic area. A close working relationship with such a specialist will clarify questions about procedures for eye screening as well as indications for referral for specialized eye examinations.

TIMING OF EXAMINATION AND SCREENING

Children should have age-appropriate assessments for eye problems in the newborn period and at all subsequent health supervision visits. Infants at risk for eye problems, such as retinopathy of prematurity, or those with family histories of congenital cataracts, retinoblastoma, and metabolic and genetic diseases should have ophthalmologic examinations

in the nursery. All infants should be examined by 6 months of age to evaluate fixation preference, ocular alignment, and the presence of any eye disease. These infants should continue to be checked until 3 or 4 years of age, when visual acuity in children can be evaluated more easily. Formal vision screening evaluations should begin at 3 years of age.

PROCEDURES FOR EYE EVALUATION

Before objective testing, an adequate history should be obtained to elicit evidence of any visual difficulties. Appropriate questions that might be asked initially would include: "Does your child seem to see well?" "Does your child hold objects unusually close to his or her face when trying to focus?" "Do the eyes appear straight?" "Do the eyes seem to cross?" It is important to listen carefully to parents who note that their children may have problems with their eyes or vision, because parents' observations often prove correct. Relevant family histories regarding eye disorders or early use of glasses always should be explored.

Eye evaluation in the physician's office should include the following:

1. External inspection of the eyes;
2. Tests for visual acuity on an age-appropriate basis;
3. Tests for ocular muscle motility and eye muscle imbalances; and
4. Ophthalmoscopic examination.

The child should be comfortable and in good health at the time of the examination and, if at all possible, should have some preparation for the testing situation. Particularly for younger children, parents should demonstrate the anticipated testing procedures. It is often convenient for the younger child to sit on the parent's lap during the procedures.

Children who have eyeglasses generally should have their vision tested while wearing the eyeglasses. However, eyeglasses prescribed for use while reading should not be worn when distance acuity is being tested.

Various tests are available to the pediatrician for assessing vision in children at various ages. Different picture tests, such as the LH test and Allen cards, can be used for children 3 to 4 years of age. Tests for children older than 4 years include wall charts containing Snellen letters, Snellen numbers, the tumbling E test, and the HOTV test (a letter-matching test involving these four letters). Consideration must

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be given to obtaining proper occlusion of the untested eye; cardboard and paddle occluders have been found to be inadequate for covering the eye. There are commercially available occluder patches that provide positive occlusion for appropriate testing (see comment 4 in "Appendix 1").¹ The distance for all vision testing except for that in which Allen cards are used should be 10 ft. Vision testing should be performed in a well-lit area. Pediatricians can achieve equally acceptable results using different techniques. A recent study of 102 pediatric practices revealed that 53% of them use screening machines.² Because screening machines may be difficult for some children 3 and 4 years of age, pediatricians should have picture cards and wall charts on hand for testing these patients.

BIRTH TO 2 YEARS OF AGE

An eye evaluation for infants and children from birth to 2 years of age should include:

1. Eyelids and orbits;
2. External examination;
3. Motility;
4. Eye muscle balance;
5. Pupils; and
6. Red reflex.

Examination of the eyelids and orbits consists of evaluating the structures for symmetry and function, such as the ability to open both eyes. Neonates and young infants generally will open their eyes when held upright or leaned slightly forward. The orbits may be evaluated by looking for asymmetrical prominence of one eye compared with the other, the presence of masses such as hemangiomas, or craniofacial abnormalities involving the orbital bones.

External examination of the eyes consists of a penlight evaluation of the conjunctiva, sclera, cornea, and iris. A cloudy or asymmetrically enlarged cornea, for example, may be a sign of congenital glaucoma. The pupils should be equal, round, and reactive to light on both sides.

The examination of ocular motility, muscle balance, and visual acuity commonly may be performed together. Although young infants may not commonly fix on a target, such as a toy, and follow it until they are at least 3 months of age, older infants should do so readily. A penlight may be used to evaluate the light reflection from the cornea, known as the corneal light reflex. These light reflections should present symmetrically on both corneas in relation to the anterior segment structures, such as the pupil. Asymmetry of the appearance of the corneal light reflex may be an indication of an eye muscle imbalance. The unilateral cover test, as described in "Appendix 2," also may be used for this purpose but may be more difficult to perform in this age group.¹

The unilateral cover test is useful only in infants and children who are able to fixate on a target. By using an interesting toy as a target and moving it up, down, and from side to side, it is possible to determine whether the eyes see together. If possible, the examiner should

cover one eye with his or her hand and continue to move the toy to see if each eye individually is able to fix on and follow the object. A sign of poor vision in one eye would be the child's objection to the other eye being covered. If the child will follow an object happily with the right eye covered but strongly objects and moves his or her head away when the examiner attempts to cover the left eye for the same purpose, poor visual acuity in the right eye may be suspected. Although very small infants may seem uninterested in looking at a toy, they commonly will follow a human face at close range.

The red reflex test is used to perform a screening evaluation for abnormalities of the back of the eye (posterior segment) and opacities in the visual axis, such as a cataract or corneal opacity. An ophthalmoscope focused on the pupil is used to view the eyes 12 to 18 in away. The red reflex should be symmetrical. Dark spots in the red reflex, a blunted red reflex on one side, the lack of a red reflex, or the presence of a white reflex are all indications for referral.

FROM 2 TO 4 YEARS OF AGE

Children older than 2 years should have the same eye evaluation as described previously for those from birth through 2 years of age; two additional measures also should be included. As children get older, vision testing and ophthalmoscopy become possible. The very earliest that vision testing is possible with picture cards is at approximately 2½ years of age. Vision testing is recommended for all children starting at 3 years of age. In the event that the child is unable to cooperate with vision testing at 3 years of age, a second attempt should be made in 4 to 6 months.³ Children who, after repeated attempts, cannot be tested should be referred to ophthalmologists experienced in the care of children for eye evaluations. "Appendix 2" provides a detailed explanation of the techniques for vision testing applicable to this age group.

Ophthalmoscopy may be possible in very cooperative 4-year-olds who are willing to fixate on a toy while the ophthalmoscope is used to evaluate the optic nerve and retinal vasculature in the posterior pole of the eye.

AT 5 YEARS AND OLDER

Eye evaluation for children 5 years and older should include the previously described components of the eye evaluation for younger children; virtually all children should be able to undergo vision testing by this time, and most children should be sufficiently cooperative for ophthalmoscopy. As for eye examinations in the age groups of birth to 2 years of age and 2 through 4 years, the frequency of examinations is in accordance with the AAP "Recommendations for Preventive Pediatric Health Care."³ Any child unable to be tested after two attempts or in whom an abnormality is detected should be referred for an initial eye evaluation by an ophthalmologist experienced in the care of children.

MUSCLE IMBALANCE TESTING

The assessment of ocular alignment in the pre-school and early school-aged child is of considerable

importance. The development of ocular muscle imbalance may occur at any age in children and may represent not only simple strabismus but also serious orbital, intraocular, and intracranial disease. The corneal light reflex test and either the unilateral cover test at near and at distance or the random-dot-E stereo test for stereoacuity (depth perception) should be carried out. The latter two tests are more likely to detect lesser degrees of eye muscle imbalance that may have significant consequences for the child's visual ability. Some children may have prominent lid folds that cover the medial portion of the sclera on both sides, presenting the impression of crossed eyes (esotropia). Corneal reflex testing, the cover test, and the random-dot-E stereo test are useful in differentiating true esotropia from pseudoesotropia. Detection of eye muscle imbalances or the inability to differentiate true strabismus from pseudostrabismus necessitates referral. "Appendix 2" describes how both tests for eye muscle imbalance are administered and interpreted.

REFRACTIVE ERRORS

Refractive errors requiring the use of eyeglasses exist in nearly 20% of the pediatric population before the late teenage years. The most common clinically significant refractive error is myopia (nearsightedness), usually seen in school-aged children and correctable with eyeglasses. Hyperopia (farsightedness) can cause problems in performing close work but usually does not necessitate correction in children unless it is sufficient to cause crossed eyes or reduced vision. Astigmatism (unequal curvature of the refractive surfaces of the eye) necessitates corrective eyeglasses if it causes significantly decreased vision or is of such severity to contribute to the development of amblyopia (lazy eye). In addition, unequal amounts of refractive error in the two eyes (anisometropia) also may lead to amblyopia and may require a prescription for corrective eyeglasses. The detection of amblyopia at an early age is an important aspect of the routine eye examination in the pediatric population. Left undetected and untreated, amblyopia may lead to irreversible visual deficit.

RECOMMENDATIONS

The pediatrician and others in the office should become expert at vision testing of young children. Although this is a difficult group to test, there can be very serious sequelae when a problem with visual acuity, ocular alignment, or another abnormality of the eyes is not identified. All newborns should be screened for risk factors involving visual problems, and all children should have their visual statuses evaluated on a regular and periodic basis.¹ The results of the vision screening and eye evaluation, along with instructions for follow-up care, should be clearly communicated to parents.² All pediatricians and other providers of care to children should be familiar with the screening guidelines of the AAPOS, AAO, and AAP. Every effort should be made to ensure that vision screening is performed using appropriate testing conditions, instruments, and techniques.

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APPENDIX 1

Vision Screening Guidelines

Vision screening represents one of the most sensitive techniques for the detection of eye abnormalities in children. Pediatricians, family physicians, school nurses, and public health vision-screening personnel have used a variety of criteria in determining which children require comprehensive eye evaluation by ophthalmologists. The AAP Section on Ophthalmology, in cooperation with AAPOS and AAO, have developed guidelines for use by all pediatric vision screening professionals to standardize the process of screening and to detect children with eye abnormalities who might be overlooked by less-stringent or inconsistent guidelines. These guidelines (Table) represent a first effort at a national standard for vision screening to be used by physicians, nurses, educational institutions, public health departments, and other childhood vision evaluation services.

APPENDIX 2

Testing Procedures for Assessing Visual Acuity

When performing screening, test the child's right eye first by covering the left. A child who has corrective eyeglasses should be screened wearing the eyeglasses. Tell the child to keep both eyes open during testing. If the child fails the practice line, move up the chart to the next larger line. If the child fails this line, continue up the chart until a line is found that the child can pass. Then move down the chart again until the child fails to read a line. After

TABLE. Vision Screening Guidelines*

Function	Recommended Tests	Referral Criteria	Comments
Ages 3–5 y Distance visual acuity	Snellen letters Snellen numbers Tumbling E HOTV Picture tests Allen figures LH test	1. <4 of 6 correct on 20-ft line with either eye tested at 10 ft monocularly (ie, <10/20 or 20/40) or 2. Two-line difference between eyes, even within the passing range (ie, 10/12.5 and 10/20 or 20/25 and 20/40)	1. Tests are listed in decreasing order of cognitive difficulty; the highest test that the child is capable of performing should be used; in general, the tumbling E or the HOTV test should be used for ages 3–5 y and Snellen letters or numbers for ages 6 y and older 2. Testing distance of 10 ft is recommended for all visual acuity tests 3. A line of figures is preferred over single figures 4. The nontested eye should be covered by an occluder held by the examiner or by an adhesive occluder patch applied to eye; the examiner must ensure that it is not possible to peek with the nontested eye
Ocular alignment	Unilateral cover test at 10 ft or 3 m or Random-dot-E stereo test at 40 cm (630 s of arc)	Any eye movement <4 of 6 correct	
Ages 6 y and older Distance visual acuity	Snellen letters Snellen numbers Tumbling E HOTV Picture tests Allen figures LH test	1. <4 of 6 correct on 15-ft line with either eye tested at 10 ft monocularly (ie, <10/15 or 20/30) or 2. Two-line difference between eyes, even within the passing range (ie, 10/10 and 10/15 or 20/20 and 20/30)	1. Tests are listed in decreasing order of cognitive difficulty; the highest test that the child is capable of performing should be used; in general, the tumbling E or the HOTV test should be used for ages 3–5 y and Snellen letters or numbers for ages 6 y and older 2. Testing distance of 10 ft is recommended for all visual acuity tests 3. A line of figures is preferred over single figures 4. The nontested eye should be covered by an occluder held by the examiner or by an adhesive occluder patch applied to the eye; the examiner must ensure that it is not possible to peek with the nontested eye
Ocular alignment	Unilateral cover test at 3 m or Random-dot-E stereo test at 40 cm (630 s of arc)	Any eye movement <4 of 6 correct	

* Vision screening guidelines were developed by the AAP Section on Ophthalmology Executive Committee, 1991–1992: Robert D. Gross, MBA, MD, Chairman; Walter M. Fierston, MD; Jane D. Kivlin, MD; I. Matthew Rabinowicz, MD; David R. Stager, MD; Mark S. Ruttum, MD, AAPOS; and Earl R. Crouch, Jr, MD, AAO.

the child has correctly identified two symbols on the 10/25 line, move to the critical line (10/20 or 20/40 equivalent). To pass a line, a child must identify at least four of the six symbols on the line correctly. Repeat the above procedure covering the right eye.

For children who may be unable to perform vision testing by letters and numbers, the tumbling E or HOTV test may be used. Literature is available from the AAO (*Home Eye Test*, AAO, San Francisco, CA) and Prevent Blindness America (*Preschoolers Home Eye Test*, Prevent Blindness America, Schaumburg, IL) for home use by parents to prepare children for the tumbling E

test. This literature contains the practice Es, a tumbling E wall chart, and specific instructions for parents.

Another excellent test for children unable to perform the vision testing by letters and numbers is the HOTV test. This test consists of a wall chart composed only of Hs, Os, Ts, and Vs. The child is provided an 8½ × 11-in board containing a large H, O, T, and V. The examiner points to a letter on the wall chart, and the child indicates or matches the correct letter on the testing board. The tumbling E test and HOTV tests are excellent tests for this age group. Examiners may determine which

test is most useful in their practices and use that test preferentially.

If a child is not able to perform the tumbling E or HOTV test, the LH symbol test or Allen card test may be used. The Allen card test is the older of the two and is well known for its commonly used figures, consisting of a schematic truck, house, birthday cake, bear, telephone, horse, and tree. The Allen card test has four flash cards containing the seven figures. It is important that a child identify either verbally or by matching all seven pictures before actual vision testing. In this case, testing should be performed with the remaining figures.

Once it is established that the child can identify the figures, perform initial testing with the child having both eyes open; testing for each eye individually should then be performed. Begin walking backward very slowly, flipping through the cards and presenting different pictures to the child. Continue to move backward as the child correctly calls out the figures presented. When the child begins to miss the figures being presented consistently, move forward several feet to confirm that the child is able to identify the figures at this point. All Allen figures are 20/30 size figures. The farthest distance at which the child is able to identify the pictures accurately becomes the numerator, and 30 becomes the denominator. Therefore, if the child were able to identify the pictures accurately at 15 ft, the visual acuity would be recorded as 15/30. This would be equivalent to 20/40 or 10/20. A matching panel of all of the Allen figures may be prepared on a copy machine and used in the same way as for HOTV testing, if necessary, for testing very young children or for practice at home.

The LH symbol test is slightly different from the Allen card test in that it is made up of flash cards held together by a spiral binding. The flash cards contain large examples of a house, apple, circle, and square; these should be presented to the child before vision testing. Unlike the Allen cards, the LH symbol test contains flash cards with more than one figure per card and with smaller figure sizes, so that testing may be performed at 10 ft. Each card contains the symbol size and visual acuity value for a 10-ft testing distance. The visual acuity is determined by the smallest symbols the child is able to identify accurately at 10 ft. For example, if the child is able to identify a symbol at 10 ft for which the visual acuity value on the card reads 10/15, the child's visual acuity is 10/15 or 20/30. If it is not possible to perform all testing at 10 ft, use a similar technique to Allen card testing and present the pictures to the child one at a time by covering all but one picture on the card and moving backward at 10 ft. At this point, proceed down in size to the smallest figures the child is consistently able to identify correctly. A matching panel is provided with the LH test and may be helpful in testing very young children. At least three of four figures should be identified for each size or distance.

Allen cards and wall charts are available from many medical supply houses. When ordering wall charts, be sure to indicate that a 10-ft testing distance will be used.

Testing Procedures for Assessing Ocular Alignment

The two tests to detect ocular misalignment are the unilateral cover test and the random-dot-E stereo test. Either test should be performed to determine whether strabismus (ocular misalignment) is present.

To perform the unilateral cover test, have the child look straight ahead at an object 10 ft (3 m) away. An eye chart is commonly used to test children older than 3 years. For younger children, it is helpful to use a colorful noise-making toy.

A child who has eyeglasses should be screened wearing the eyeglasses. As the child looks at a distant object, cover the left eye with an occluder, and look for movement of the uncovered right eye. If the right eye does not move, there is no apparent misalignment of that eye. If the right eye moves outward, the eye is esotropic (crossed). If the right eye moves inward, it is exotropic (out-turned). Any movement is the criterion for referral to an ophthalmologist.

After testing the right eye, test the left eye for movement. Occlude the right eye and look for movement of the uncovered left eye. If the left eye does not move, there is no apparent misalignment of that eye. If the left eye moves outward or inward, this meets the criterion for referral to an ophthalmologist.

To perform the random-dot-E stereo test, the cards should be held 16 in (40 cm) from the child's eyes. Explain the game to the child. Show the child the gray side of the card that says "model" on it. Hold the model E in the direction at which the child can read it correctly. Have the child touch the model E to understand better that the picture will stand out. A child may show which direction the legs are pointing. Let the child know that is correct, but it is more important that the child knows that the picture will stick out.

Place the stereo glasses on the child. If the child is wearing corrective eyeglasses, place the stereo glasses over the glasses. Make sure the glasses stay on the child and the child is looking straight ahead. The child should be shown both the stereo blank card and the raised and recessed E card simultaneously. Hold each card so you can read the back. The blank card should be held so you can read it. The E card should be held so you can read the word "raised." Both cards must be held straight. Do not tilt the cards toward the floor or the ceiling—this will cause darkness and glare. Ask the child to look at both cards and to point to or touch the card with the picture of the E. The E must be presented randomly, switching from side to side. Use the following order to present the E card to the child: right, left, down, right, up, and left. The child is shown the cards up to six times. To pass the test, a child must identify the E correctly in four of six attempts.

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