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Preschool Vision Screening: Summary of a Task Force Report

E. Eugenie Hartmann, PhD‡; Velma Dobson, PhD§; Louise Hainline, PhD‖; Wendy Marsh-Tootle, OD, MS‖||; Graham E. Quinn, MD#; Mark S. Ruttum, MD**; Paulette P. Schmidt, OD, MS‡‡; and Kurt Simons, PhD§§, on Behalf of the Maternal and Child Health Bureau and the National Eye Institute Task Force on Vision Screening in the Preschool Child

Vision screening to detect eye problems in school-aged children dates back at least a century.1 Calls to screen specifically for amblyopia, generally defined as monocular decreased acuity, began appearing by the 1950s.2 However, it was not until the 1960s, when animal research indicated that cortical plasticity was limited to a period early in life, that emphasis was placed on vision screening in the preschool years. Since that time, a variety of preschool screening programs have been adopted in various countries,3 ranging from the systematic and thorough efforts of Scandinavian countries that evaluate screening methods and outcome from infancy through preschool ages,4,5 to the diversity of screening standards (Table 1) and screening programs found in different jurisdictions across the United States.5,6

Recommendations for health-related screening programs, developed by the World Health Organization,7 require that a disorder suitable for mass screening should have a high prevalence in the population, should result in significant impairment to the individual, and should be treatable at the time of its detection. Although the Scandinavian experience and other data make clear the effectiveness of preschool screening in reducing visual morbidity from amblyopia,8–10 fundamental questions remain about specific issues, ranging from screening methodology to quantitative measures of both efficacy and cost-effectiveness of such screening. These questions were recently brought to focus by a report from the United Kingdom questioning the utility of preschool vision screening.11–13 Although both the data interpretation and conclusions of this report have been questioned,14–23 it has given impetus to a reexamination of the why and how of preschool vision screening.

Recognizing the growing list of questions about preschool vision screening and the lack of consistency in preschool vision screening recommendations and programs in the United States, Congress urged the Maternal and Child Health Bureau in the Health Resources and Services Administration to consult with the National Eye Institute of the National Institutes of Health, Department of Health and Human Services, and various national and state agencies, to review both research and policy issues involved in vision screening in preschool-aged children. The specific request was to determine “useful screens to efficiently detect amblyopia risk factors and other significant problems” and “to provide and evaluate the practicality and effectiveness of ocular screening services for young children, including photoscreening technology.” As a result of this recommendation, an expert panel convened in September 1998, and a report from this panel was released in May 1999.24

There were 2 major outcomes of the expert panel’s deliberations.

OUTCOME 1
Lack of Data on Validity and Effectiveness of Current Screening Methodologies and Programs

The panel expressed concern about the lack of scientific data addressing the validity of currently available screening methodologies, the effectiveness of the programs that are being used to implement these methodologies, and the adequacy of follow-up and treatment of children identified by screening programs. Members acknowledged an urgent need for large-scale, generalizable studies aimed at answering basic questions about the reliability and validity of commonly used screening methods, as well as new technologies, such as photoscreening. The panel also emphasized the importance of monitoring both the costs and benefits of a screening program, compared with the cost of leaving visual impairments undetected, and recommended that research be conducted to provide objective data on the functional implications of amblyopia.

One of the forces driving the convening of the expert panel was the increasing availability and implementation of photoscreening in preschool settings. Photoscreening, in principal, represents one of...
the most dramatic developments in the history of preschool vision screening.8 This technique can be applied in early infancy and opens up the possibility of detecting risk factors in a “latent” period before the onset of amblyopia itself. Photoscreening has several advantages over conventional screening techniques. Most notably, it is easier to use with these often difficult-to-test individuals than typical recognition acuity tests and the resulting photographs (or video images) can provide a quantifiable objective measure. Nonetheless, current photoscreening technologies typically require some degree of interpretation of the results by the examiner. Furthermore, photoscreeners measure amblyopia risk factors not amblyopia itself and, therefore, the efficacy of detecting amblyopiogenic risk factors before the onset of amblyopia must be compared with that of more traditional vision screening programs designed to detect amblyopia once it has developed.25,26

Current research indicates that caution should be applied in the use of photoscreening devices in preschool vision screening. Adequate validation studies are lacking for most devices in this rapidly evolving field, and studies comparing the merits of different instrument designs are almost completely absent. Research using novel technology requires representative screening populations, real-world screening settings, and masked clinical gold standard comparison examinations. Compounding the problem of evaluation of new devices is the basic science question of just which amblyopiogenic conditions a photoscreener should be detecting. Conditions such as esotropia and media opacification are well-established as risk factors for amblyopia, but the type and extent of refractive error that actually produce amblyopia and the importance of the age of appearance of such risk factors are not adequately specified by current research.8,27,28

### TABLE 1. Current Recommendations for Preschool Vision Screening Programs

<table>
<thead>
<tr>
<th>Organization</th>
<th>Age (Years)</th>
<th>Vision Disorders</th>
<th>Method (Any of the Following)</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Academy of Pediatrics</td>
<td>3–5</td>
<td>1) Amblyopia</td>
<td>1) Snellen letters, Snellen numbers, Tumbling E, HOTV, Picture tests, Allen figures, Lea test (all 3 m)</td>
</tr>
<tr>
<td>American Academy of Ophthalmology</td>
<td></td>
<td>2) Strabismus (ocular misalignment)</td>
<td>2) Unilateral cover test (at 3 m) or Random Dot E stereotest (at 40 cm)</td>
</tr>
<tr>
<td>American Association of Pediatric Ophthalmology and Strabismus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Optometric Association</td>
<td>2–6</td>
<td>1) Amblyopia</td>
<td>1) Monocular visual acuity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) High refractive error</td>
<td>2) Patient history, Brückner test, Monocular visual acuity, Plus lens test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Ocular misalignment/strabismus</td>
<td>3) Patient history, observation, Brückner test, Hirschberg, cover test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4) Color vision deficiencies</td>
<td>4) Ishihara plates or equivalent</td>
</tr>
<tr>
<td>Prevent Blindness America</td>
<td>3–4</td>
<td>1) Eye health</td>
<td>1) Observation/questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Reduced visual acuity</td>
<td>2) Early Treatment for Diabetic Retinopathy Study letters, HOTV letters, Lea chart, Tumbling E (all charts at 3 m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Reduced stereopsis</td>
<td>3) Random Dot E Stereotest</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4) Other (unspecified)</td>
<td>4) Optional tests include: cover test, corneal reflection test, plus lens tests; they are not recommended. State recommendations may vary</td>
</tr>
<tr>
<td>Head Start Program</td>
<td>3</td>
<td>1) Reduced visual acuity</td>
<td>1) Tumbling E (at 3 m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Strabismus</td>
<td>2) Cover test/Hirschberg test</td>
</tr>
<tr>
<td>US Public Health Service</td>
<td>3–4</td>
<td>Amblyopia and strabismus</td>
<td>Stereotesting, such as Random Dot E stereotest, visual acuity testing, Snellen letters, Snellen numbers, Tumbling E, HOTV, Allen figures, Lea test (all above tests listed in order of decreasing cognitive ability; use test with highest level of which child is capable)</td>
</tr>
<tr>
<td>Maternal and Child Health Bureau</td>
<td>3–5</td>
<td>Reduced visual acuity, Ocular misalignment</td>
<td>American Academy of Pediatrics/American Academy of Ophthalmology/American Association of Pediatric Ophthalmology and Strabismus criteria as noted above</td>
</tr>
</tbody>
</table>
correction of refractive error poses no risk to an adult, question has been raised as to whether it may interfere with the normalization of refractive errors, known as emmetropization, that occurs in infants and young children.8,28–30

**OUTCOME 2**

**Interim Screening Recommendations**

The panel concluded its work by confronting the question of what recommendations should be made for preschool screening at the present time, before the research outlined above has been completed. Although a variety of recommendations have been published by various organizations5,24 (Table 1), the panel believed that the recommendations are inconsistent and, therefore, confusing. In particular, as shown in Table 1, different tests are recommended by different agencies with little guidance for the selection and implementation of the test.31 The panel, therefore, constructed a set of interim recommendations to detect amblyopia and amblyopiogenic factors using assessment of visual acuity and stereopsis (Table 2). The recommendations are more explicit with regard to the specific tests and methodology to be used than are previous such recommendations, to assist personnel responsible for undertaking screening. However, it should be emphasized that these recommendations are conditional and not based on adequate validation data, since such data are not yet available.

The recommendations are intended for use with 3- and 4-year-old children, since fewer than one half of 3-year-olds are screened in pediatric practices with current methods.32 The most direct way to detect amblyopia (monocular decreased vision) is to assess monocular visual acuity. For visual acuity assessment, the tests recommended are HOTV, Lea symbols, or tumbling E charts, because they allow screening of younger children (see Fig 1). Isolated optotypes with surround bars are also acceptable (see Fig 2). In addition, a testing

### Table 2. Recommendations for Vision Screening Age Range: 36 to 59 Months

<table>
<thead>
<tr>
<th>Function to be Evaluated</th>
<th>Type of Test</th>
<th>Specific Test</th>
<th>Recommended Testing Procedures</th>
<th>Passing Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monocular distance acuity</td>
<td>1) Linear acuity</td>
<td>1) HOTV, Lea symbols, Tumbling E</td>
<td>Test distance = 10 ft (3 m) Pretest (performed binocularly)</td>
<td>Child must identify or match 4 of 5 optotypes on the critical line with each eye tested monocularly. Critical lines 20/40 at 36–48 mo 20/30 at 48–59 mo</td>
</tr>
<tr>
<td></td>
<td>2) Isolated optotypes</td>
<td>2) HOTV cards with surround bars</td>
<td>Test child’s ability to perform test by having child identify or match each of the 4 optotypes on a line that is expected to be suprathreshold (20/100 or greater). Child must successfully identify each of the 4 optotypes. Repeat test procedure with the other eye.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with surround bars</td>
<td></td>
<td>Pretest (performed binocularly)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NB: isolated optotypes</td>
<td></td>
<td>Test child’s ability to perform test by having child identify or match each of the 4 optotypes on the pretest line. Then test child’s ability to identify or match optotypes on the critical line. Repeat test procedure with the other eye.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>without surround bars</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>should not be used:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>they overestimate acuity in individuals with amblyopia.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stereopsis</td>
<td>Random dot stereogram</td>
<td>Random Dot E</td>
<td>Test distance = 40 cm (630 arcsec)</td>
<td>Child must locate stereo E on 4 of 5 presentations.*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>All testing, including pretesting, should be performed binocularly with the polarized glasses on.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pretest Test child’s ability to perform test by having child identify the location of the 3-dimensional E on 4 of 5 trials (E on left or right; above or below).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Test procedure Test child’s ability to identify the location of the stereo E. Tester should use 5 presentations, varying location in a nonsystematic manner.</td>
<td></td>
</tr>
</tbody>
</table>

* From a statistical perspective, it would be ideal to require that a child pass 5 of 5 trials, because the probability of achieving this criterion by simply guessing is <5%. In reality, many children will have difficulty attending consistently for 5 trials. Therefore, the 4 of 5 correct passing criterion is considered acceptable, even though the probability of passing by chance is 16.5%.
procedure and passing criteria are specified. Stereopsis testing is included to detect strabismus as an amblyogenic factor. A specific test, the Random Dot E, is recommended (see Fig 3). Again the testing procedure and passing criteria are specified. (Further details of testing procedures can be found in the complete Proceedings from the Panel. All tests are commercially available.)

THE NEXT STEP

A critical and unique feature of the expert panel and audience convened for these discussions was the wide range of disciplines represented. Researchers studying early visual development, clinicians (pediatricians, pediatric ophthalmologists, and optometrists), various professionals with direct experience in vision screening in the United States and other countries, biostatisticians, epidemiologists, and health care economists all participated. This wide representation was deliberately chosen to reflect the fact that vision screening is necessarily conducted by a variety of agencies and specialists. One of the major successes of this meeting was the overall agreement among the array of disciplines represented concerning the importance of vision screening in preschool children and the need for continuing work in the realms of both application and research.

The review process begun by the expert panel will be continued under a new initiative being sponsored by the Maternal and Child Health Bureau that will be administered by the American Academy of Pediatrics: Project Universal Preschool Vision Screening. The goal of this initiative is to convene a task force that will include State Maternal and Child Health staff, State Children with Special Health Care Needs staff, the Association of Maternal and Child Health Programs

Fig 1A. HOTV chart that provides 4 choices for the young child: H, O, T, and V.
staff, pediatric and family practice professional organizations, consumer organizations cognizant of vision screening issues and needs, and vision experts. The mandate of this broad-based, multidisciplinary task force will be: 1) to analyze the expert panel's recommended guidelines (Table 2) for their applicability to State vision screening programs; 2) to develop standardized recommendations that can be implemented at the State level; 3) to address issues of reimbursement to health professionals for screening, thereby providing incentive for wider adoption of vision screening; 4) to analyze the costs of amblyopia treatment, both financial and in terms of social impact on the child and family; and 5) to propose a system to monitor the States' preschool vision screening efforts. Further endorsement of these goals is found in the Healthy People 2010 initiative sponsored by the Department of Health and Human Services. Specifically, increasing "the proportion of preschool children aged 5 years and under who receive vision screening" has been identified as 1 of the 10 objectives in the area of visual health.

APPENDIX

MATERNAL AND CHILD HEALTH BUREAU AND THE
NATIONAL EYE INSTITUTE TASK FORCE ON VISION
SCREENING
E. Eugenie Hartmann, PhD, Chairperson

STEERING COMMITTEE MEMBERS
Velma Dobson, PhD
Louise Hainline, PhD
Wendy Marsh-Tootle, OD, MS
Graham E. Quinn, MD
Mark S. Ruttum, MD

Fig 1B. Lea chart that has 4 choices of symbols: apple, circle, house, and square.
Fig 1C. Tumbling E chart with a capital E presented with the arms pointed up, down, left, or right.
REFERENCES

ABSTRACT


Context. Practice guidelines play an important role in medicine. Methodological principles have been formulated to guide their development.

Objective. To determine whether practice guidelines in peer-reviewed medical literature adhered to established methodological standards for practice guidelines.


Main Outcome Measures. Mean number of standards met based on a 25-item instrument and frequency of adherence.

Conclusion. Guidelines published in the peer-reviewed medical literature during the past decade do not adhere well to established methodological standards. While all areas of guideline development need improvement, greatest improvement is needed in the identification, evaluation, and synthesis of the scientific evidence.

Noted by JFL, MD
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