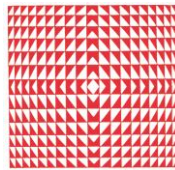


PREFERRED PRACTICE PATTERN®



Pediatric Eye Evaluations

- I. Vision Screening in the
Primary Care and
Community Setting
- II. Comprehensive Ophthalmic
Examination

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PEDIATRIC OPHTHALMOLOGY/ STRABISMUS PREFERRED PRACTICE PATTERN® DEVELOPMENT PROCESS AND PARTICIPANTS

The **Pediatric Ophthalmology/Strabismus Preferred Practice Pattern® Panel** members wrote the Pediatric Eye Evaluations Preferred Practice Pattern® guidelines ("PPP"). The PPP Panel members discussed and reviewed successive drafts of the document, meeting in person twice and conducting other review by e-mail discussion, to develop a consensus over the final version of the document.

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The **Preferred Practice Patterns Committee** members reviewed and discussed the document during a meeting in March 2012. The document was edited in response to the discussion and comments.

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The Pediatric Eye Evaluations PPP was then sent for review to additional internal and external groups and individuals in June 2012. All those returning comments were required to provide disclosure of relevant relationships with industry to have their comments considered. Members of the Pediatric Ophthalmology/Strabismus PPP Panel reviewed and discussed these comments and determined revisions to the document. The following organizations and individuals returned comments.

Academy Reviewers

Board of Trustees and Committee of Secretaries
Council

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Ophthalmic Technology Assessment Committee

Pediatric Ophthalmology/Strabismus Panel

Practicing Ophthalmologists Advisory Committee
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American Association for Pediatric Ophthalmology
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FINANCIAL DISCLOSURES

In compliance with the Council of Medical Specialty Societies' Code for Interactions with Companies (available at www.cmss.org/codeforinteractions.aspx), relevant relationships with industry are listed. The Academy has Relationship with Industry Procedures to comply with the Code (available at <http://one.aao.org/CE/PracticeGuidelines/PPP.aspx>). A majority (87%) of the members of the Pediatric Ophthalmology/Strabismus Preferred Practice Pattern Panel 2011–2012 had no financial relationship to disclose.

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The disclosures of relevant relationships to industry of other reviewers of the document from January to August 2012 are available online at www.aao.org/ppp.



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OBJECTIVES OF PREFERRED PRACTICE PATTERN® GUIDELINES

As a service to its members and the public, the American Academy of Ophthalmology has developed a series of Preferred Practice Pattern® guidelines that **identify characteristics and components of quality eye care**. Appendix 1 describes the core criteria of quality eye care.

The Preferred Practice Pattern® guidelines are based on the best available scientific data as interpreted by panels of knowledgeable health professionals. In some instances, such as when results of carefully conducted clinical trials are available, the data are particularly persuasive and provide clear guidance. In other instances, the panels have to rely on their collective judgment and evaluation of available evidence.

These documents provide guidance for the pattern of practice, not for the care of a particular individual. While they should generally meet the needs of most patients, they cannot possibly best meet the needs of all patients. Adherence to these PPPs will not ensure a successful outcome in every situation. These practice patterns should not be deemed inclusive of all proper methods of care or exclusive of other methods of care reasonably directed at obtaining the best results. It may be necessary to approach different patients' needs in different ways. The physician must make the ultimate judgment about the propriety of the care of a particular patient in light of all of the circumstances presented by that patient. The American Academy of Ophthalmology is available to assist members in resolving ethical dilemmas that arise in the course of ophthalmic practice.

Preferred Practice Pattern® guidelines are not medical standards to be adhered to in all individual situations. The Academy specifically disclaims any and all liability for injury or other damages of any kind, from negligence or otherwise, for any and all claims that may arise out of the use of any recommendations or other information contained herein.

References to certain drugs, instruments, and other products are made for illustrative purposes only and are not intended to constitute an endorsement of such. Such material may include information on applications that are not considered community standard, that reflect indications not included in approved U.S. Food and Drug Administration (FDA) labeling, or that are approved for use only in restricted research settings. The FDA has stated that it is the responsibility of the physician to determine the FDA status of each drug or device he or she wishes to use, and to use them with appropriate patient consent in compliance with applicable law.

Innovation in medicine is essential to ensure the future health of the American public, and the Academy encourages the development of new diagnostic and therapeutic methods that will improve eye care. It is essential to recognize that true medical excellence is achieved only when the patients' needs are the foremost consideration.

All Preferred Practice Pattern® guidelines are reviewed by their parent panel annually or earlier if developments warrant and updated accordingly. To ensure that all PPPs are current, each is valid for 5 years from the "approved by" date unless superseded by a revision. Preferred Practice Pattern guidelines are funded by the Academy without commercial support. Authors and reviewers of PPPs are volunteers and do not receive any financial compensation for their contributions to the documents. The PPPs are externally reviewed by experts and stakeholders, including consumer representatives, before publication. The PPPs are developed in compliance with the Council of Medical Specialty Societies' Code for Interactions with Companies. The Academy has Relationship with Industry Procedures (available at <http://one.aao.org/CE/PracticeGuidelines/PPP.aspx>) to comply with the Code.

The intended users of Section I of the Pediatric Eye Evaluations PPP are physicians, nurses, and other providers who perform eye and vision screening. The intended users of Section II of the Pediatric Eye Evaluations PPP are ophthalmologists.



METHODS AND KEY TO RATINGS

Preferred Practice Pattern® guidelines should be clinically relevant and specific enough to provide useful information to practitioners. Where evidence exists to support a recommendation for care, the recommendation should be given an explicit rating that shows the strength of evidence. To accomplish these aims, methods from the Scottish Intercollegiate Guideline Network¹ (SIGN) and the Grading of Recommendations Assessment, Development and Evaluation² (GRADE) group are used. GRADE is a systematic approach to grading the strength of the total body of evidence that is available to support recommendations on a specific clinical management issue. Organizations that have adopted GRADE include SIGN, the World Health Organization, the Agency for Healthcare Research and Policy, and the American College of Physicians.³

- ◆ All studies used to form a recommendation for care are graded for strength of evidence individually, and that grade is listed with the study citation.
- ◆ To rate individual studies, a scale based on SIGN¹ is used. The definitions and levels of evidence to rate individual studies are as follows:

I++	High-quality meta-analyses, systematic reviews of randomized controlled trials (RCTs), or RCTs with a very low risk of bias
I+	Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias
I-	Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias
II++	High-quality systematic reviews of case-control or cohort studies High-quality case-control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
II+	Well-conducted case-control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
II-	Case-control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
III	Nonanalytic studies (e.g., case reports, case series)

- ◆ Recommendations for care are formed based on the body of the evidence. The body of evidence quality ratings are defined by GRADE² as follows:

Good quality	Further research is very unlikely to change our confidence in the estimate of effect
Moderate quality	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate
Insufficient quality	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate Any estimate of effect is very uncertain

- ◆ Key recommendations for care are defined by GRADE² as follows:

Strong recommendation	Used when the desirable effects of an intervention clearly outweigh the undesirable effects or clearly do not
Discretionary recommendation	Used when the trade-offs are less certain—either because of low-quality evidence or because evidence suggests that desirable and undesirable effects are closely balanced

- ◆ The Highlighted Recommendations for Care section lists points determined by the PPP Panel to be of particular importance to vision and quality of life outcomes.
- ◆ Literature searches to update the PPP were undertaken in April 2011 in PubMed and the Cochrane Library and updated in March 2012. Complete details of the literature search are available at www.aao.org/ppp.



HIGHLIGHTED RECOMMENDATIONS FOR CARE

Vision screening should be performed at an early age and at regular intervals throughout childhood. The elements of vision screening vary depending on the age and level of cooperation of the child.
(*strong recommendation, moderate evidence*)

Age-Appropriate Methods for Pediatric Vision Screening and Criteria for Referral

Method	Indications for Referral	Recommended Age				
		Newborn–6 mos	6 mos and until child is able to cooperate for subjective VA testing	3–4 yrs	4–5 yrs	Every 1–2 yrs after age 5 yrs
Red reflex test	Absent, white, dull, opacified, or asymmetric	◆	◆	◆	◆	◆
External inspection	Structural abnormality (e.g., ptosis)	◆	◆	◆	◆	◆
Pupillary examination	Irregular shape, unequal size, poor or unequal reaction to light	◆	◆	◆	◆	◆
Fix and follow	Failure to fix and follow	Cooperative infant >3 mos	◆			
Corneal light reflection	Asymmetric or displaced		◆	◆	◆	◆
Instrument-based screening*	Failure to meet screening criteria		◆	◆	◆	◆
Cover test	Refixation movement			◆	◆	◆
Distance visual acuity† (monocular)	20/50 or worse in either eye			◆	◆	◆
	20/40 or worse in either eye				◆	◆
	Worse than 3 of 5 optotypes on 20/30 line, or 2 lines of difference between the eyes					◆

NOTE: These recommendations are based on panel consensus. If screening is inconclusive or unsatisfactory, the child should be retested within 6 months; if inconclusive on retesting or if retesting cannot be performed, referral for a comprehensive eye evaluation is indicated.⁴

VA = visual acuity

* Subjective visual acuity testing is preferred to instrument-based screening in children who are able to participate reliably. Instrument-based screening is useful for young children and those with developmental delays.

† LEA Symbols⁵ (Good-Lite Co., Elgin, IL), HOTV, and Sloan Letters⁶ are preferred optotypes.

The choice and arrangement of optotypes (letters, numbers, symbols) on an eye chart can significantly affect the visual acuity score obtained. Preferred optotypes are standardized and validated.
(*strong recommendation, good evidence*)

Vision testing with single optotypes is likely to overestimate visual acuity in a patient who has amblyopia. A more accurate assessment of monocular visual acuity is obtained by presenting of a line of optotypes or a single optotype with crowding bars that surround (or crowd) the optotype being identified.
(*strong recommendation, good evidence*)

Refractive correction should be prescribed for children according to the following guidelines.
(*discretionary recommendation, insufficient evidence*)

Guidelines for Refractive Correction in Infants and Young Children

Condition	Refractive Errors (diopters)		
	Age <1 year	Age 1–2 years	Age 2–3 years
Isoametropia (similar refractive error in both eyes)			
Myopia	–5.00 or more	–4.00 or more	–3.00 or more
Hyperopia (no manifest deviation)	+6.00 or more	+5.00 or more	+4.50 or more
Hyperopia with esotropia	+2.50 or more	+2.00 or more	+1.50 or more
Astigmatism	3.00 or more	2.50 or more	2.00 or more
Anisometropia (without strabismus)*			
Myopia	–4.00 or more	–3.00 or more	–3.00 or more
Hyperopia	+2.50 or more	+2.00 or more	+1.50 or more
Astigmatism	2.50 or more	2.00 or more	2.00 or more

NOTE: These values were generated by consensus and are based solely on professional experience and clinical impressions because there are no scientifically rigorous published data for guidance. The exact values are unknown and may differ among age groups; they are presented as general guidelines that should be tailored to the individual child. Specific guidelines for older children are not provided because refractive correction is determined by the severity of the refractive error, visual acuity, and visual symptoms.

* Threshold for correction of anisometropia should be lower if the child has strabismus. The values represent the minimum difference in the magnitude of refractive error between eyes that would prompt refractive correction.

SECTION I. VISION SCREENING IN THE PRIMARY CARE AND COMMUNITY SETTING



INTRODUCTION

Vision screening for children is an evaluation to detect reduced visual acuity or risk factors that threaten the healthy growth and development of the eye and visual system.

Vision screening in the primary care setting is usually performed during health supervision visits by a nurse or other trained health professionals. Community vision screening may be performed in preschools, in daycares, at schools, or at health fairs. Community screenings can be performed by health professionals or trained lay persons.

PATIENT POPULATION

Infants and children through age 18 years.

OBJECTIVES FOR VISION SCREENING

- ◆ Educate screening personnel
- ◆ Assess vision, ocular alignment, and the presence of ocular structural abnormalities
- ◆ Communicate the screening results and follow-up plan to the family/caregiver
- ◆ Refer all children who either fail screening or who are untestable for a comprehensive eye examination
- ◆ Verify that the recommended comprehensive eye examination has occurred



BACKGROUND

EPIDEMIOLOGY OF CHILDHOOD VISUAL IMPAIRMENT

In the first year of life, abnormalities such as congenital cataract, retinopathy of prematurity, congenital glaucoma, retinoblastoma (a vision- and life-threatening malignancy), and cerebral visual impairment are severe vision-threatening eye problems. Other childhood ocular problems include strabismus, amblyopia, refractive problems, and uveitis. Table 1 lists prevalence and incidence data for these childhood ocular conditions.

Strabismus is any binocular misalignment. The common types of strabismus are esotropia (inwardly deviating eyes) and exotropia (outwardly deviating eyes). In the United States, esotropia and exotropia have similar prevalence rates, whereas in Ireland esotropia is reported five times more frequently than exotropia, and in Australia esotropia has been reported to be twice as frequent as exotropia.^{7,8} In Hong Kong and Japan, however, exotropia is more frequent than esotropia.^{9,10} Amblyopia can both cause and result from a manifest strabismus.^{11,12} Approximately 50% of children who have strabismus develop amblyopia.^{13,14} Because binocular vision can degrade rapidly in young children, resulting in suppression and anomalous retinal correspondence, early diagnosis and treatment of strabismus are essential.^{12,15,16}

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Section I. Vision Screening in the Primary Care and Community Setting

TABLE 1 CHILDHOOD OCULAR CONDITIONS

Condition	Frequency
Congenital cataract	0.02% ^{17,18} (prevalence in children aged 0 to 1 year) 0.42% ¹⁹ (prevalence in children aged 6 to 15 years)
Retinopathy of prematurity	52% ²⁰ (incidence in infants <750 g at birth) 32% ²⁰ (incidence in infants 750 g to 799 g at birth) 15% ²⁰ (incidence in infants 1000 g to 1250 g at birth)
Congenital glaucoma	0.0015% to 0.0054% ^{21,22} (incidence in children aged <20 years)
Retinoblastoma	0.005% ²³ (incidence in children aged <15 years)
Cerebral visual impairment	Accurate prevalence or incidence data are lacking
Strabismus	1% to 3% ^{7,24} (prevalence in children aged 6 to 72 months)
Amblyopia	1% to 3% ^{7,24} (prevalence in children aged 6 to 72 months) 0.8% to 2% ²⁴ (prevalence in children aged 30 to 71 months)
Refractive errors	
Myopia (−1.0 D or more in eye with lesser refractive error)	0.7% to 5% ^{25,26} (prevalence in children aged 5 to 17 years)
Hyperopia (+3.0 D or more in eye with lesser refractive error)	4% to 9% ^{25,26} (prevalence in children aged 5 to 17 years)
Astigmatism (worse eye cylinder power 3.0 D or more)	0.5% to 3% ^{25,27} (prevalence in children aged 5 to 17 years)
Pediatric uveitis	Incidence 0.004% ²⁸ (yearly incidence in children aged <16 years)

Amblyopia refers to an abnormality of visual development characterized by decreased best-corrected visual acuity in a normal eye or in an eye with a structural abnormality in which visual acuity is not fully attributable to the structural anomaly of the eye. Amblyopia may be unilateral or bilateral and is best treated in early childhood for optimal outcomes. However, recent data show that amblyopia may be treated and possibly improved even in the teenage years.²⁹ The prevalence of amblyopia varies by race/ethnicity.^{7,24} Approximately half of amblyopia is secondary to strabismus (mainly esotropia) and the other half is from other causes such as high refractive errors and anisometropia (asymmetric refractive errors), or they occur in conjunction with structural ocular problems.^{13,14,30,31} Amblyopia is unusual in children with intermittent exotropia.³² The prevalence of amblyopia in children with developmental delay is sixfold greater than in children who were healthy, full-term infants.^{33,34} Recent studies found the prevalence of strabismic amblyopia appears to be similar in left and right eyes; however, most studies confirm a greater percentage (53% to 64%) of anisometropic amblyopia in left eyes.³³⁻³⁵ In the United States, amblyopia affects over 6 million people, and it is responsible for permanently reduced vision in more people under the age of 45 than for all other causes of visual disability combined.³⁶

Refractive error is a common cause of visual problems in children. Visually important refractive errors include high hyperopia, moderate to high astigmatism, moderate to high myopia, and asymmetric refractive errors. An estimated 5% to 7% of preschool children have visually significant refractive errors.³⁷ Twenty-five percent of children between the ages of 6 and 18 years would benefit from corrective lenses for refractive error or other reasons.^{26,38,39} Incidence rates vary with age and race/ethnicity.

Premature birth is a risk factor for severe visual impairment and blindness in childhood. The most common ocular problem in preterm infants is retinopathy of prematurity. The frequency and severity of retinopathy of prematurity is inversely related to gestational age and birth weight.⁴⁰ Preterm infants also have higher rates of amblyopia, strabismus, refractive error, optic atrophy, and cortical visual impairment.⁴¹⁻⁴⁶ Years later, these children may develop glaucoma and retinal detachment.^{43,44} The visual impairment is often accompanied by cerebral palsy, epilepsy, and other motor and intellectual disabilities.^{44,47} Experts recognize that among children with visual disability, cortical impairment is an important contributor to vision loss. Some studies suggest that at least 25% of children with visual disability have a cortical component.⁴⁸⁻⁵⁰ However, there is a lack of robust population-based studies for accurate incidence or prevalence data.

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Uveitis, while less common, is recognized as an important and treatable cause of ocular morbidity in children.⁵¹ Uveitis can be due to infectious or inflammatory causes,⁵² but the most frequent specific causes are juvenile idiopathic arthritis and toxoplasma retinochoroiditis.⁵³ Prompt diagnosis and treatment of the uveitis are critical to preserving visual function, and identification of any associated systemic infectious or inflammatory disease is also essential for the well-being of the child.

RATIONALE FOR PERIODIC VISION SCREENING

The purpose of periodic eye and vision screening is to identify children who may have eye disorders, particularly those that contribute to the development of amblyopia, at a sufficiently early age to allow effective treatment. Parents or caregivers may be unaware of the consequences of delayed care.⁵⁴ Because amblyopia does not always present with signs or symptoms that are apparent to parents or caregivers, children with amblyopia may seem to have normal visual function until formally tested. Amblyopia, therefore, meets the World Health Organization guidelines for a disease that benefits from screening because it is an important health problem for which there is an accepted treatment, it has a recognizable latent or early symptomatic stage, and a suitable test or examination is available to diagnose the condition.^{55,56}

Vision screening should be performed periodically throughout childhood.⁵⁷⁻⁶⁷ The combined sensitivity of a series of screening encounters is much higher than that of a single screening test, particularly if different methods are used.⁶⁷ In addition, eye problems can present at different stages throughout childhood.

Several governmental and service organizations have developed policies on vision screening and most clinical authorities, including the American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, American Academy of Pediatrics (AAP), and United States Preventive Services Task Force (USPSTF), recommend some form of periodic vision screening for asymptomatic children.⁶⁸⁻⁷⁰ (See Appendix 2 for a list of policies for vision screening for children.) The USPSTF found indirect evidence demonstrating that a number of screening tests can identify many preschool-aged children who have vision problems. The USPSTF found further indirect evidence suggesting that treatment for amblyopia or unilateral refractive error (with or without amblyopia) is associated with improvement in visual acuity compared with no treatment. However, no randomized controlled trials or cohort studies were identified that explicitly addressed the optimal timing or process of pediatric vision screening from birth to 18 years of age. The USPSTF^{37,71} and a Cochrane Review⁷² failed to find evidence for or against vision screening for asymptomatic children under the age of 3 years. The evidence base for vision screening in children under the age of 3 is limited by a paucity of studies evaluating screening techniques that are feasible for this age group of children such as red reflex testing and objective vision screening such as photoscreening and autorefractometry.^{73,74} Studies are also needed to ascertain whether there are any risks for potential unintended harm from screening.⁵⁸

Although there is limited direct evidence demonstrating the effectiveness of preschool vision screening in reducing the prevalence of amblyopia or in improving other health outcomes,^{70,72,75,76} a convincing chain of indirect evidence supports the practice of preschool vision screening. Several methods of vision screening in preschoolers have been shown to be effective in detecting children at risk for amblyopia, and amblyopia treatment results in an improvement in visual acuity relative to no treatment.^{70,77,78} In addition, mounting evidence indicates that successful treatment of visual disability sustains or improves quality of life.^{79,80} The earlier amblyopia is detected and properly treated, the higher the likelihood of visual acuity recovery.^{57-60,81-87} With rare exceptions,^{86,88} amblyopia results in lifelong permanent visual loss and potential detrimental consequences in areas of educational achievement, sports participation, psychosocial well-being, and occupational selection if it is untreated or insufficiently treated in early childhood.^{76,89} Recognizing such indirect evidence, and despite limitations in direct evidence, expert opinion supports vision screening throughout childhood in primary care and community settings.⁷⁰



VISION SCREENING PROCESS

The optimal timing and method of pediatric vision screening has not been definitively established. Guidelines for pediatric vision screening continue to evolve as new tests are introduced and new studies are completed.

HISTORY

A history that addresses risk factors for eye problems is important. This history is readily obtained in settings where a primary caregiver is likely to be present, but it is more challenging to assess at screenings performed in daycare settings and schools.

Parental/caregiver observations on the overall quality of the child's vision, eye alignment, and structural features of the eyes and ocular adnexa are invaluable. Poor eye contact by the infant with the caretaker after 8 weeks of age may warrant further assessment. A detailed family history of vision problems, including strabismus, amblyopia, congenital cataract, congenital glaucoma, retinoblastoma, and ocular or systemic genetic disease, should be elicited whenever possible. Special attention should be paid to children with a history of known medical risk factors for the development of vision problems, including prematurity, Down syndrome, and cerebral palsy. The presence of neuropsychological conditions or learning issues in school should be sought. At each health supervision visit or subsequent screening, the screener should ask about the overall quality of the child's vision. Children with medical conditions that place them at higher risk for eye problems should receive a comprehensive ophthalmic examination soon after diagnosis.

VISION SCREENING AND REFERRAL PLAN

The elements of vision screening vary depending on the age and level of cooperation of the child (see Table 2). The content of the vision screening may also depend on state and federal mandates, the availability of objective vision-screening devices, and the skills of the examiner. Lay screeners may be less comfortable performing more sophisticated examination elements.

Primary care providers should perform vision screening of newborns and infants under 6 months of age. Screening should include red reflex testing to detect abnormalities of the ocular media, external inspection of ocular and periocular structures, pupillary examination, and assessment of fixation and following behavior. Findings that would warrant referral of newborns and infants to an ophthalmologist for a comprehensive eye examination following a vision screening are listed in Table 2.

Primary care providers also provide vision screening of older infants and toddlers. After 6 months of age, an assessment of binocular alignment should also be performed because children should have aligned eyes at age 4 to 6 months. Instrument-based screening with photoscreening or autorefraction devices can be valuable in detecting amblyopia risk factors in this age group because the tests are rapid and noninvasive and minimal cooperation is required on the part of the child.⁹⁰ Indications for referral to an ophthalmologist are included in Table 2.

Pediatric Eye Evaluations PPP:
Section I. Vision Screening in the Primary Care and Community Setting

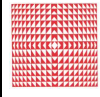
	Vision screening should be performed at an early age and at regular intervals throughout childhood (Table 2). The elements of vision screening vary depending on the age and level of cooperation of the child. (<i>strong recommendation, moderate evidence</i>)
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TABLE 2 AGE-APPROPRIATE METHODS FOR PEDIATRIC VISION SCREENING AND CRITERIA FOR REFERRAL

Method	Indications for Referral	Recommended Age				
		Newborn–6 mos	6 mos and until child is able to cooperate for subjective VA testing	3–4 yrs	4–5 yrs	Every 1–2 yrs after age 5 yrs
Red reflex test	Absent, white, dull, opacified, or asymmetric	◆	◆	◆	◆	◆
External inspection	Structural abnormality (e.g., ptosis)	◆	◆	◆	◆	◆
Pupillary examination	Irregular shape, unequal size, poor or unequal reaction to light	◆	◆	◆	◆	◆
Fix and follow	Failure to fix and follow	Cooperative infant >3 mos	◆			
Corneal light reflection	Asymmetric or displaced		◆	◆	◆	◆
Instrument-based screening*	Failure to meet screening criteria		◆	◆	◆	◆
Cover test	Refixation movement			◆	◆	◆
Distance visual acuity† (monocular)	20/50 or worse in either eye			◆	◆	◆
	20/40 or worse in either eye				◆	◆
	Worse than 3 of 5 optotypes on 20/30 line, or 2 lines of difference between the eyes					◆

NOTE: These recommendations are based on panel consensus. If screening is inconclusive or unsatisfactory, the child should be retested within 6 months; if inconclusive on retesting or if retesting cannot be performed, referral for a comprehensive eye evaluation is indicated.⁴

VA = visual acuity

* Subjective visual acuity testing is preferred to instrument-based screening in children who are able to participate reliably. Instrument-based screening is useful for young children and those with developmental delays.

† LEA Symbols⁵ (Good-Lite Co., Elgin, IL), HOTV, and Sloan Letters⁶ are preferred optotypes.

Many 3-year-old children are able to perform subjective visual acuity testing. After this age, visual acuity testing becomes the focus of vision screening. Several tests with appropriate optotypes for young children are available.^{77,91} Several other symbol charts have serious limitations for young children because the optotypes are not standardized and/or the optotypes are presented in a confusing fashion.^{92,93} Detailed information on effective and efficient subjective visual acuity testing is offered in the Comprehensive Ophthalmic Evaluation section of this PPP.

Children who fail to complete subjective visual acuity assessment are considered untestable. Untestable preschoolers are more likely to have vision disorders than testable children.⁴ Children who are untestable should be retested within 6 months or referred for a comprehensive eye examination. Children who complete the subjective visual acuity assessment but fail the examination should be referred for a comprehensive eye examination after the first screening failure. Additional findings that would warrant referral of a 3- to 5-year-old child for a comprehensive ophthalmic examination are included in Table 2. Children should continue to have periodic vision screenings throughout childhood and adolescence because problems may arise at later stages throughout development.⁹⁴

For more information on red reflex examination, external inspection, pupillary examination, fix and follow, corneal light reflection, cover test, and instrument-based screening, see Appendix 3.

PROVIDERS

Physicians, nurses, other health care providers, and lay persons who perform vision screening should be trained to elicit a specified review of risk factors for vision problems, detect structural eye problems, and assess visual abilities or acuities at every age. Screeners should be trained in the techniques that are used to test younger children and children with neuropsychological conditions or developmental delays.

SECTION II. COMPREHENSIVE OPHTHALMIC EXAMINATION



INTRODUCTION

The majority of healthy children should have several vision screenings during childhood. Comprehensive eye examinations are not necessary for healthy asymptomatic children who have passed an acceptable vision screening test, have no subjective visual symptoms, and have no personal or familial risk factors for eye disease,⁹⁵ but they may be performed if the parent/caregiver desires. It is recommended that children be referred for a comprehensive eye examination if they fail a vision screening, are untestable, have a vision complaint or an observed abnormal visual behavior, or are at risk for the development of eye problems. Children with medical conditions (e.g., Down syndrome, prematurity, juvenile idiopathic arthritis, neurofibromatosis) or a family history of amblyopia, strabismus, retinoblastoma congenital cataracts, or congenital glaucoma are at higher risk for developing eye problems. Health supervision guidelines exist for many of these conditions.⁹⁶⁻¹⁰⁴ In addition, children with learning disabilities benefit from a comprehensive eye evaluation to rule out the presence of ocular comorbidities.^{105,106} Finally, some children who have developmental delays, intellectual disabilities, neuropsychological conditions, and/or behavioral issues that render them untestable by other caregivers benefit greatly from a comprehensive eye examination by an ophthalmologist who is skilled in working with children.

PATIENT POPULATION

Infants and children through age 18 years.

OBJECTIVES FOR COMPREHENSIVE OPHTHALMIC EXAMINATION

- ◆ Identify risk factors for ocular disease
- ◆ Identify systemic disease based on associated ocular findings
- ◆ Identify factors that may predispose to visual loss early in a child's life
- ◆ Determine the health status of the eye and related structures, visual system, and assess refractive errors
- ◆ Discuss the nature of the findings of the examination and their implications with the parent/caregiver, primary care provider and, when appropriate, the patient
- ◆ Initiate an appropriate management plan (e.g., treatment, counseling, further diagnostic tests, referral, follow-up, early intervention services* for newborns to children up to age 3 years or individual education plan in the public school system for children older than 3 years¹⁰⁷)

* Under U.S. federal law, early intervention services for children of any age with visual impairments are available from public school districts and regional centers.



CARE PROCESS

Comprehensive eye examinations differ in technique, instrumentation, and diagnostic capacity from child to child, depending on the child's age, developmental status, level of cooperation, and ability to interact with the examiner. The components include the following elements.

HISTORY

Although a thorough history generally includes the following items, the exact composition varies with the patient's particular problems and needs:

- ◆ Demographic data, including gender, date of birth, and identity of parent/caregiver
- ◆ The identity of the historian, relationship to child, and any language barriers that may exist
- ◆ The identity of other pertinent health care providers
- ◆ The chief complaint and reason for the eye evaluation
- ◆ Current eye problems
- ◆ Ocular history, including prior eye problems, diseases, diagnoses, and treatments
- ◆ Systemic history, birth weight, gestational age, prenatal and perinatal history that may be pertinent (e.g., history of infections or substance or drug exposure during pregnancy), past hospitalizations and operations, and general health and development
- ◆ Current medications and allergies
- ◆ Family history of eye conditions and relevant systemic diseases
- ◆ Social history, including racial or ethnic heritage
- ◆ Review of systems

EXAMINATION

The pediatric eye examination consists of an assessment of the physiologic function and the anatomic status of the eye and visual system. Documentation of the child's level of cooperation with the examination can be useful in interpreting the results. The order of the examination may vary depending on the child's level of cooperation. Testing of sensory function should be performed before any dissociating examination techniques (e.g., covering an eye to check monocular visual acuity, cover testing to assess alignment) are done. Binocular alignment testing should be done prior to cycloplegia. The examination should include the following elements:

- ◆ Binocular red reflex (Brückner) test
- ◆ Binocularity/stereoacuity testing
- ◆ Assessment of fixation pattern and visual acuity
- ◆ Binocular alignment and ocular motility
- ◆ Pupillary examination
- ◆ External examination
- ◆ Anterior segment examination
- ◆ Cycloplegic retinoscopy/refraction
- ◆ Funduscopy examination

Binocular Red Reflex (Brückner) Test

In a darkened room, the direct ophthalmoscope light should be directed toward both eyes of the child simultaneously from approximately 18 to 30 inches (45 to 75 centimeters). To be considered normal, a symmetric red reflex should be observed from both eyes. Opacities in the red reflex, a markedly diminished reflex, the presence of a white or yellow reflex, or asymmetry of the reflexes are all considered abnormal. The red reflex varies based on retinal pigmentation and, thus, varies by race/ethnicity. Significant hyperopia will present as an inferiorly placed brighter crescent in the red reflex. Significant myopia presents as a superiorly placed brighter crescent.

Binocularity/Stereoacuity Testing

Binocularity, or binocular vision, consists of several different components, including sensory fusion, stereopsis, fusional vergence (motor fusion), and other coordinated binocular eye movements. These types of binocular vision are sensitive to disruption by amblyopia, strabismus, refractive error, and deprivation, but each can be affected to different degrees depending on the underlying diagnosis. Tests to evaluate each of these components of binocular vision include the Worth 4-dot Test (sensory fusion), the Randot test (stereopsis), and vergence testing with a prism bar or rotary prism (fusional vergence).^{108,109} Assessment of stereoacuity is an important component of binocular alignment testing because high-grade stereoacuity is associated with normal alignment. Testing of sensory function should be performed before any dissociating examination techniques (e.g., covering an eye to check monocular visual acuity, cover testing to assess alignment) are done. Binocular alignment testing should be done before cycloplegia.

Assessment of Fixation Pattern and Visual Acuity

Fixation

Visual acuity measurement of the infant and toddler involves a qualitative assessment of fixation and tracking (following) movements of the eyes. Fixation and following are assessed by drawing the child's attention to the examiner or caregiver's face (infants under 3 months) or to a hand-held light, toy, or other accommodative fixation target and then slowly moving the target. Fixation behavior can be recorded for each eye as "fixes and follows" or "central, steady, and maintained."

Fixation preference can be assessed by observing the vigor with which the child objects to occlusion of one eye relative to the other: children resist covering an eye when the fellow eye has limited vision.¹¹⁰⁻¹¹² Grading schemes can be used to describe fixation preference. For strabismic patients, fixation pattern is assessed binocularly by determining the length of time that the nonpreferred eye holds fixation. Fixation pattern can be graded by whether the nonpreferred eye will not hold fixation, holds momentarily, holds for a few seconds (or to or through a blink), or by observation of spontaneous alternation of fixation. For children with small-angle strabismus or no strabismus, the induced tropia test is typically done by holding a 10 to 20 prism diopter base-down prism over one eye and then the other eye and noting fixation behavior.¹¹²⁻¹¹⁴

Qualitative assessment of visual acuity should be replaced with a visual acuity test based on optotypes (letters, numbers, or symbols) as soon as the child can perform this task.

Visual Acuity

Recognition visual acuity testing, which involves identifying optotypes, including letters, numbers, or symbols, is preferred for assessment of visual acuity to detect amblyopia. The optotypes may be presented on a wall chart, computer screen, or hand-held card. Visual acuity is routinely tested at distance (10 to 20 feet or 3 to 6 meters) and at near (14 to 16 inches or 35

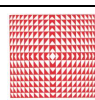
to 40 centimeters). Under ideal circumstances, visual acuity testing conditions should be standardized so that results obtained over a series of visits can be readily compared. High-contrast charts with black optotypes on a white background should be used for standard visual acuity testing.⁹³

A child's performance on a visual acuity test will be dependent on the choice of chart and the examiner's skills and rapport with the child. To reduce errors, the environment should be quiet. Younger children may benefit from a pretest on optotypes presented at near, either at the start of testing or in a separate session. Before monocular testing, the examiner should ensure that the child is able to perform the test reliably. Allowing children to match optotypes on the chart to those found on a hand-held card will enhance performance, especially in young, shy, or cognitively impaired children. Visual acuity testing of children with special needs can provide quantitative information about visual impairment and reduce concerns of parents/caregivers about the child's vision.¹¹⁵ A shorter testing distance or flip chart can also facilitate testing in younger children.⁹¹

Visual acuity testing should be performed monocularly and with refractive correction in place. Ideally the fellow eye is covered with an adhesive patch or tape. If such occlusion is not available or tolerated by the child, care must be taken to prevent the child from peeking and using the "covered" eye. Sometimes the child will not allow any monocular occlusion, in which case binocular visual acuity should be measured. Monocular visual acuity testing for patients with nystagmus requires special techniques such as blurring of the fellow eye with plus lenses or a translucent occluder rather than using opaque occlusion. Binocular visual acuity testing can also be performed for these patients to provide additional information about typical visual performance.

The choice and arrangement of optotypes on an eye chart can significantly affect the visual acuity score obtained.¹¹⁶⁻¹¹⁸ Optotypes should be clear, standardized, of similar characteristics, and should not reflect a cultural bias.⁹³ LEA Symbols (Good-Lite Co., Elgin, IL), a set of four symbol optotypes developed for use with young children, are useful because each optotype blurs similarly as the child is presented with smaller symbols, increasing the reliability that individual symbols will be identified.^{5,116} Another method for testing the young child uses a chart containing only the letters H, O, T, and V.^{116,119} Children who cannot name the symbols on the LEA Symbol chart or the letters on the HOTV chart may be able to match them using a hand-held card. Desirable optotypes for older children are LEA numbers and Sloan letters.⁶ Snellen letters are less desirable because the individual letters are not of equal legibility and the spacing of the letters does not meet World Health Organization standards.^{93,120-122}

Several other symbol charts have serious limitations in testing visual acuity of young children. These include Allen figures,¹²³ the Lighthouse chart, and the Kindergarten Eye Chart.¹²⁴ In these charts, the optotypes are not standardized to blur equally and/or the optotypes are presented in a culturally biased or confusing fashion.⁹² The Illiterate or Tumbling E chart is conceptually difficult for young children, leading to high untestability rates.¹²⁴ Appendix 4 lists the details of design of visual acuity testing charts. Some charts meet recommended criteria,⁹³ although many do not.



The choice and arrangement of optotypes (letters, numbers, symbols) on an eye chart can significantly affect the visual acuity score obtained. Preferred optotypes are standardized and validated. (*strong recommendation, good evidence*)

The arrangement of optotypes on the chart is important.⁹² Optotypes should be presented in a full line of five whenever possible. Children should correctly identify the majority of optotypes on a line to "pass" the line. A similar number of optotypes on each line with equal spacing is preferred. In the setting of amblyopia, visual acuity testing with single optotypes is likely to overestimate acuity¹²⁵⁻¹²⁷ because of the crowding phenomenon. In amblyopia, it is easier to discriminate an isolated optotype than one presented in a line of optotypes. Therefore, a more

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Section II. Comprehensive Ophthalmic Examination

accurate assessment of monocular visual acuity is obtained in amblyopia with the presentation of a line of optotypes. Optotypes should not be covered or masked as the examiner points to each successive symbol in order to preserve the crowding effect of adjacent optotypes. If a single optotype must be used to facilitate visual acuity testing for some children, the optotype should be surrounded (crowded) by bars placed above, below, and on either side of the optotype to account for the crowding phenomenon and not overestimate visual acuity.¹²⁸⁻¹³⁰



Vision testing with single optotypes is likely to overestimate visual acuity in a patient with amblyopia. A more accurate assessment of monocular visual acuity is obtained with the presentation of a line of optotypes or a single optotype with crowding bars that surround (or crowd) the optotype being identified. (*strong recommendation, good evidence*)

The Teller Acuity Cards (Stereo Optical Co., Inc., Chicago, IL) are a test of forced preferential looking and can provide a general assessment of resolution visual acuity in young children and how the patient's acuity compares with normative data, but this method of testing overestimates recognition visual acuity in children with amblyopia.^{131,132}

Binocular Alignment and Ocular Motility

The corneal light reflection, binocular red reflex (Brückner) test, and cover tests are commonly used to assess binocular alignment. Cover/uncover tests for tropias and alternate cover tests for the total deviation (latent component included) in primary gaze at distance and near should utilize accommodative targets. Cover tests require sufficient visual acuity and cooperation to fix on the desired target. Ocular versions and ductions, including into the oblique fields of gaze, should be tested in all infants and children. Eye movements may be tested using oculocephalic rotation (doll's head maneuver) or assessed by spontaneous eye movements in the inattentive or uncooperative child.

Pupillary Examination

The pupils should be assessed for size, symmetry, and shape; for their direct and consensual responses to light; and for presence of a relative afferent defect. Pupillary evaluation in infants and children may be difficult due to hippus, poorly maintained fixation, and rapid changes in accommodative status. Anisocoria greater than 1 mm may indicate a pathological process, such as Horner syndrome, Adie tonic pupil, or a pupil-involving third-cranial-nerve palsy. Irregular pupils may indicate the presence of traumatic sphincter damage, iritis, or a congenital abnormality (e.g., coloboma). A relative afferent pupillary defect of large magnitude is not typically seen in amblyopia¹³³; its presence should warrant a search for compressive or other etiologies of visual impairment (e.g., optic nerve or retinal abnormality).

External Examination

The external examination involves assessment of the eyelids, eyelashes, lacrimal apparatus, and orbit. Components may include assessment of proptosis, amount of ptosis and levator function, presence of lid retraction, and relative position of the globe within the orbit (e.g., proptosis or globe retraction, hypoglobus, or hyperglobus). Older children who have the appearance of proptosis may tolerate measurement using an exophthalmometer. For uncooperative or younger children, proptosis of the globe may be estimated by comparing the position of the globes when viewing from above the head. The anatomy of the face (including the lids, interocular distance, and presence or absence of epicanthal folds), orbital rim, and presence of oculofacial anomalies should be noted. The position of the head and face (including head tilt or turn and chin-up or chin-down head posture) should be recorded. Children who have prominent epicanthal folds and/or a wide, flat nasal bridge and normal binocular alignment often appear to have an esotropia (pseudoesotropia). Distinctive features unusual for the family may suggest the presence of a congenital anomaly and merit an assessment to identify additional physical abnormalities (e.g., ears, hands) that might require further evaluation.

Anterior Segment Examination

The cornea, conjunctiva, anterior chamber, iris, and lens should be evaluated using slit-lamp biomicroscopy, if possible. For infants and young children, anterior segment examination with a direct ophthalmoscope, a magnifying lens such as that used for indirect ophthalmoscopy, or a hand-held slit-lamp biomicroscope may be helpful.

Cycloplegic Retinoscopy/Refraction

Determination of refractive errors is important in the diagnosis and treatment of amblyopia or strabismus. Patients should undergo cycloplegic refraction with retinoscopy and subjective refinement when possible.¹⁰⁸ Before cycloplegia, dynamic retinoscopy provides a rapid assessment of accommodation and may be helpful in evaluating a child with asthenopia who has high hyperopia or the child with accommodative insufficiency.^{134,135}

Adequate cycloplegia is necessary for accurate retinoscopy in children due to their increased accommodative tone compared with adults. Cyclopentolate hydrochloride is useful because it produces rapid cycloplegia that approximates the effect of topical ophthalmic atropine 1% solution but with a shorter duration of action.¹³⁶ Cyclopentolate 1% solution is typically used in term infants over 6 months old. The dose of cyclopentolate should be determined based on the child's weight, iris color, and dilation history. In eyes with heavily pigmented irides, repeating the cycloplegic eyedrops or using adjunctive agents such as phenylephrine hydrochloride 2.5% (has no cycloplegic effect) or tropicamide 0.5% or 1.0% may be necessary to achieve adequate dilation to facilitate retinoscopy. Tropicamide and phenylephrine may be used in combination to produce adequate dilation size, but this combination may not be strong enough for adequate cycloplegia in children. A single eyedrop combination of cyclopentolate 0.2% and phenylephrine 1% is safe and effective for infants with dark irides.¹³⁷ In rare cases, topical ophthalmic atropine sulphate 1% solution may be necessary to achieve maximal cycloplegia.¹³⁶ The use of topical anesthetic prior to the cycloplegic reduces the stinging of subsequent eyedrops and promotes its penetration into the eye.¹³⁸ Cycloplegic and dilating agents may be compounded in spray forms that provide similar dilation and cycloplegia with equal or greater patient satisfaction.¹³⁹⁻¹⁴¹ Short-term side effects of cycloplegic and dilating agents may include hypersensitivity reactions, fever, dry mouth, rapid pulse, nausea, vomiting, flushing, and, rarely, behavioral changes.

Funduscopy Examination

The optic disc, macula, retina, vessels, and the choroid should be examined, preferably using an indirect ophthalmoscope and condensing lens after adequate dilation is achieved. It may be impossible to examine the peripheral retina of the awake child. Examination of the peripheral retina with an eyelid speculum and scleral depression may require swaddling, sedation, or general anesthesia.

OTHER TESTS

Based on the patient's history and findings, additional tests or evaluations that are not routinely part of the comprehensive ophthalmic evaluation may be indicated. Components that may be included if the child cooperates are sensorimotor evaluation, color vision testing, measurement of IOP, and visual field testing. Photography of facial or ocular structural abnormalities may be helpful for documentation and follow-up.

Sensorimotor Evaluation

A sensorimotor examination consists of measurements of binocular alignment in more than one field of gaze. It also includes sensory tests of binocular function when appropriate (e.g., testing of binocular sensory status [stereoacuity or Worth 4-dot]; diplopia-free visual field; measurement of ocular torsion [double Maddox rods]; and assessment of whether horizontal, vertical, and torsional components require correction in order to restore binocular alignment [use of prism or a synoptophore]).

Color-Vision Testing

Color-vision testing is usually performed with pseudoisochromatic plates. Ishihara pseudoisochromatic plates with simple objects instead of numbers are available for children who cannot yet identify numbers. The Hardy-Rand-Rittler test is an alternative pseudoisochromatic color test that has a high sensitivity.¹⁴² Eight percent of males and less than 1% of females are color deficient.¹⁴³ Demonstration of color-vision deficits in asymptomatic children is of limited clinical value but may be of interest to parents or teachers.

Intraocular Pressure Measurement

Intraocular pressure measurement is not necessary for every child because glaucoma is rare in this age group and, when present, usually has additional manifestations (e.g., buphthalmos, epiphora, photosensitivity, and corneal clouding). Intraocular pressure should be measured whenever glaucoma or its risk factors exist. Because IOP measurement can be difficult in some children, a separate examination with the patient sedated or anesthetized may be required. The introduction of more compact instruments such as the Tono-Pen (Reichert Inc., Depew, New York), Perkins tonometer (Haag-Streit UK Ltd., Harlow, United Kingdom), and Icare rebound tonometer (Icare Finland Oy, Helsinki, Finland) have facilitated testing of IOP in children.^{144,145} Central corneal thickness measurement may be helpful in the interpretation of IOP.¹⁴⁶⁻¹⁴⁹

Visual Field Testing

Confrontation visual field testing may be performed in children. The peripheral visual field of younger children can be assessed by observation for refixation to the field of gaze in which an object of interest has been presented. A young child may mimic the number of fingers held in different quadrants of the visual field while looking at the examiner's face. Older children may count the examiner's fingers when presented in all quadrants of the visual field for each eye. Quantitative visual field testing should be attempted when indicated; reliability may be a concern, although performance may improve with practice.

Imaging

Photography or imaging in conjunction with the comprehensive pediatric eye examination may be appropriate to document and follow changes of facial or ocular structural abnormalities. Examples of indications to image include external photography for orbital or adnexal masses, strabismus, ptosis, or facial structure abnormalities; anterior segment photography for cataract and other anomalies; corneal topography to detect early changes related to keratoconus; and image analysis for optic nerve head assessment or abnormal retinal pathology.

DIAGNOSIS AND MANAGEMENT

When the eye examination is normal or involves only the correction of a refractive error, and the child does not have risk factors for the development of eye disease, the ophthalmologist reassures the patient and the parent/caregiver and establishes an appropriate interval for re-examination. If re-examination has been determined to be unnecessary, patients should return for a comprehensive eye evaluation if new ocular symptoms, signs, or risk factors for ocular disease develop. Periodic vision screening should be continued (see Table 2).

When the history reveals risk factors for developing ocular disease or the examination shows potential signs of an abnormal condition, the ophthalmologist should determine an appropriate treatment and management plan for each child based on the findings and the age of the child. Periodic vision screening may be discontinued if the child is routinely followed with comprehensive eye evaluations (see Table 2).

When ocular disease is present, a treatment and management plan should be established and may involve observation, eyeglasses, topical or systemic medications, occlusion therapy, eye exercises, and/or surgical procedures. The ophthalmologist should communicate the examination findings and the need for further evaluation, testing, treatment, or follow-up to parents/caregivers, and the patient and the patient's primary care physician or other specialists, as appropriate. Further evaluation or referral to other medical specialists may be advised.

Amblyopia, esotropia, and exotropia are discussed in the Amblyopia PPP⁸³ and the Esotropia and Exotropia PPP,¹⁵⁰ respectively.

Refractive correction is prescribed for children to improve visual acuity, alignment, and binocularity and to reduce asthenopia. Refractive correction plays an important role in the treatment of amblyopia (see Amblyopia PPP⁸³).

Table 3 provides guidelines for refractive correction in infants and young children. Lesser refractive errors may also warrant correction depending on the clinical situation.

Factors that enable children to wear eyeglasses successfully include a correct prescription, frames that fit well, and positive reinforcement. Children require updates in eyeglasses much more frequently than adults due to ocular changes and associated changes in refraction.

Infants and children with cerebral visual impairment and Down syndrome and those prescribed seizure medication may have poor accommodation and refractive needs that are different for otherwise typically developing infants and toddlers.


	Refractive correction should be prescribed for children according to the guidelines in Table 3. (discretionary recommendation, insufficient evidence)
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TABLE 3 GUIDELINES FOR REFRACTIVE CORRECTION IN INFANTS AND YOUNG CHILDREN

Condition	Refractive Errors (diopters)		
	Age <1 year	Age 1–2 years	Age 2–3 years
Isoametropia (similar refractive error in both eyes)			
Myopia	–5.00 or more	–4.00 or more	–3.00 or more
Hyperopia (no manifest deviation)	+6.00 or more	+5.00 or more	+4.50 or more
Hyperopia with esotropia	+2.50 or more	+2.00 or more	+1.50 or more
Astigmatism	3.00 or more	2.50 or more	2.00 or more
Anisometropia (without strabismus)*			
Myopia	–4.00 or more	–3.00 or more	–3.00 or more
Hyperopia	+2.50 or more	+2.00 or more	+1.50 or more
Astigmatism	2.50 or more	2.00 or more	2.00 or more

NOTE: These values were generated by consensus and are based solely on professional experience and clinical impressions because there are no scientifically rigorous published data for guidance. The exact values are unknown and may differ among age groups; they are presented as general guidelines that should be tailored to the individual child. Specific guidelines for older children are not provided because refractive correction is determined by the severity of the refractive error, visual acuity, and visual symptoms.

* Threshold for correction of anisometropia should be lower if the child has strabismus. The values represent the minimum difference in the magnitude of refractive error between eyes that would prompt refractive correction.

PROVIDER AND SETTING

Certain diagnostic procedures may be delegated to appropriately trained and supervised personnel under the ophthalmologist's supervision. For cases in which the diagnosis or management is difficult, consultation with or referral to an ophthalmologist who specializes in the diagnosis and treatment of pediatric patients may be desirable.

COUNSELING AND REFERRAL

The ophthalmologist should discuss the findings and any need for further evaluation, testing, or treatment with the child and/or family/caregiver, as appropriate. When a hereditary eye disease is identified, the parent/caregiver may be advised to have other family members evaluated and counseled for risk to subsequent pregnancies, which may include referral to a geneticist.¹⁵¹ Families with financial hardship or with a child who has a new diagnosis of a sight- or life-threatening condition may benefit from referral to social services. Patients with bilateral visual impairment should be offered contact information for early intervention and/or vision rehabilitation services.¹⁰⁷ Many ocular/neurological diagnoses qualify the newborn and children up to 3 years old for free early intervention services under Part C of the Individuals with Disabilities Education Act (<http://idea.ed.gov>).

SOCIOECONOMIC CONSIDERATIONS

There is consensus that timely and appropriate eye care can significantly improve children's quality of life and can reduce the burden of eye disease. Several important pediatric eye conditions can be asymptomatic, and children may be unaware and/or unable to express vision problems, therefore, timely treatment relies on early diagnosis.^{83,150,152} Many authorities recommend early and regular vision screening to detect these conditions.

Evidence suggests that many children do not receive the recommended care. In fact, almost 40% of children in the United States have never undergone a vision screening.^{153,154} Children in low-income families, in uninsured families, and in racial and ethnic minority groups may fare even worse.¹⁵³⁻¹⁵⁶ Studies indicate that in general African American children and children living below 400% of the federal poverty level receive fewer and less intensive services relative to their non-Latino white or more affluent counterparts.^{155,157} There is evidence that these race-ethnicity disparities are reflected in eye care services as well as in other health services.¹⁵⁷ It is still unclear whether these disparities in eye care services are due to underdiagnosis and undertreatment of certain conditions in minority children, a lower prevalence of treatable eye conditions in certain populations, racial/ethnic differences in access to care or in preferences for treatment, or a combination of these factors.¹⁵⁵

Barriers to eye care extend beyond inadequate screening and diagnosis. Screening programs vary in their ability to ensure access to eye examinations and treatment for children who fail screening. In 15 screening programs in the United States, the rate of referred children receiving a follow-up examination was over 70% in 4 programs but was below 50% in the other 11 programs.¹⁵⁸ Barriers to care may include inadequate information, lack of access to care, limited financial means, and insurance coverage and reimbursement issues.^{159,160} Children with diagnosed eye conditions require greater use of medical services than children without such conditions, and their families incur higher out-of-pocket expenditures.¹⁵⁷ In keeping with other measures of disparity in the provision of health services, non-Hispanic whites and families of higher socioeconomic status may be more likely to obtain follow-up eye care.¹⁵⁹

At the state level, legislatures have attempted to close the gap by mandating some form of vision screening for children.¹⁶¹ Legislative efforts have focused primarily on early detection of vision problems in young children. Leaders in these efforts have stressed the importance of funding mechanisms to support such programs, specifically advocating separate and additional coverage for vision screening in primary care offices as a pathway to success.¹⁶¹

The optimal provision of eye and vision care for children involves an organized program of vision screening in the primary care and community settings. It also includes referral for comprehensive eye examinations when indicated and provision of refractive aids as needed. There is a pressing need for studies to assess the impact of these interventions over time and across diverse populations.



APPENDIX 1. QUALITY OF OPHTHALMIC CARE CORE CRITERIA

*Providing quality care
is the physician's foremost ethical obligation, and is
the basis of public trust in physicians.*

AMA Board of Trustees, 1986

Quality ophthalmic care is provided in a manner and with the skill that is consistent with the best interests of the patient. The discussion that follows characterizes the core elements of such care.

The ophthalmologist is first and foremost a physician. As such, the ophthalmologist demonstrates compassion and concern for the individual, and utilizes the science and art of medicine to help alleviate patient fear and suffering. The ophthalmologist strives to develop and maintain clinical skills at the highest feasible level, consistent with the needs of patients, through training and continuing education. The ophthalmologist evaluates those skills and medical knowledge in relation to the needs of the patient and responds accordingly. The ophthalmologist also ensures that needy patients receive necessary care directly or through referral to appropriate persons and facilities that will provide such care, and he or she supports activities that promote health and prevent disease and disability.

The ophthalmologist recognizes that disease places patients in a disadvantaged, dependent state. The ophthalmologist respects the dignity and integrity of his or her patients, and does not exploit their vulnerability.

Quality ophthalmic care has the following optimal attributes, among others.

- ◆ The essence of quality care is a meaningful partnership relationship between patient and physician. The ophthalmologist strives to communicate effectively with his or her patients, listening carefully to their needs and concerns. In turn, the ophthalmologist educates his or her patients about the nature and prognosis of their condition and about proper and appropriate therapeutic modalities. This is to ensure their meaningful participation (appropriate to their unique physical, intellectual, and emotional state) in decisions affecting their management and care, to improve their motivation and compliance with the agreed plan of treatment, and to help alleviate their fears and concerns.
- ◆ The ophthalmologist uses his or her best judgment in choosing and timing appropriate diagnostic and therapeutic modalities as well as the frequency of evaluation and follow-up, with due regard to the urgency and nature of the patient's condition and unique needs and desires.
- ◆ The ophthalmologist carries out only those procedures for which he or she is adequately trained, experienced, and competent, or, when necessary, is assisted by someone who is, depending on the urgency of the problem and availability and accessibility of alternative providers.
- ◆ Patients are assured access to, and continuity of, needed and appropriate ophthalmic care, which can be described as follows.
 - ◆ The ophthalmologist treats patients with due regard to timeliness, appropriateness, and his or her own ability to provide such care.
 - ◆ The operating ophthalmologist makes adequate provision for appropriate pre- and postoperative patient care.
 - ◆ When the ophthalmologist is unavailable for his or her patient, he or she provides appropriate alternate ophthalmic care, with adequate mechanisms for informing patients of the existence of such care and procedures for obtaining it.
 - ◆ The ophthalmologist refers patients to other ophthalmologists and eye care providers based on the timeliness and appropriateness of such referral, the patient's needs, the competence and qualifications of the person to whom the referral is made, and access and availability.
 - ◆ The ophthalmologist seeks appropriate consultation with due regard to the nature of the ocular or other medical or surgical problem. Consultants are suggested for their skill, competence, and accessibility. They receive as complete and accurate an accounting of the problem as necessary to provide efficient and effective advice or intervention, and in turn they respond in an adequate and timely manner.

Pediatric Eye Evaluations PPP:
Appendix 1. Quality of Ophthalmic Care Core Criteria

- ◆ The ophthalmologist maintains complete and accurate medical records.
- ◆ On appropriate request, the ophthalmologist provides a full and accurate rendering of the patient's records in his or her possession.
- ◆ The ophthalmologist reviews the results of consultations and laboratory tests in a timely and effective manner and takes appropriate actions.
- ◆ The ophthalmologist and those who assist in providing care identify themselves and their profession.
- ◆ For patients whose conditions fail to respond to treatment and for whom further treatment is unavailable, the ophthalmologist provides proper professional support, counseling, rehabilitative and social services, and referral as appropriate and accessible.
- ◆ Prior to therapeutic or invasive diagnostic procedures, the ophthalmologist becomes appropriately conversant with the patient's condition by collecting pertinent historical information and performing relevant preoperative examinations. Additionally, he or she enables the patient to reach a fully informed decision by providing an accurate and truthful explanation of the diagnosis; the nature, purpose, risks, benefits, and probability of success of the proposed treatment and of alternative treatment; and the risks and benefits of no treatment.
- ◆ The ophthalmologist adopts new technology (e.g., drugs, devices, surgical techniques) in judicious fashion, appropriate to the cost and potential benefit relative to existing alternatives and to its demonstrated safety and efficacy.
- ◆ The ophthalmologist enhances the quality of care he or she provides by periodically reviewing and assessing his or her personal performance in relation to established standards, and by revising or altering his or her practices and techniques appropriately.
- ◆ The ophthalmologist improves ophthalmic care by communicating to colleagues, through appropriate professional channels, knowledge gained through clinical research and practice. This includes alerting colleagues of instances of unusual or unexpected rates of complications and problems related to new drugs, devices, or procedures.
- ◆ The ophthalmologist provides care in suitably staffed and equipped facilities adequate to deal with potential ocular and systemic complications requiring immediate attention.
- ◆ The ophthalmologist also provides ophthalmic care in a manner that is cost effective without unacceptably compromising accepted standards of quality.

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APPENDIX 2. POLICIES FOR VISION SCREENING IN CHILDREN

Table A2-1 displays the policies for vision screening in children from professional, governmental, and service organizations.

TABLE A2-1 SUMMARY OF RECOMMENDATIONS FOR VISION SCREENING IN CHILDREN

Organization	Document Title, Most Recent Update	Population	Frequency	Examination
American Academy of Pediatrics, American Association of Certified Orthoptists, American Association for Pediatric Ophthalmology and Strabismus, American Academy of Ophthalmology	Joint Policy Statement. Eye Examination in Infants, Children and Young Adults by Pediatricians (Pediatrics 2003;111:902-907). Document reaffirmed in 5/2007. Recommendations for preventative pediatric health care (Pediatrics 1995;96:373).	Birth to 3 years*	At all health supervision visits	Vision assessment External inspection Ocular motility assessment Pupillary examination Red reflex examination
		3 years and older*	Annually through 5 years and then at 10, 12, 15, and 18 years	Age-appropriate visual acuity measurement External inspection Ocular motility assessment Pupillary examination Red reflex examination Attempt at ophthalmoscopy
American Academy of Pediatrics, American Association for Pediatric Ophthalmology and Strabismus, American Academy of Ophthalmology, American Association of Certified Orthoptists	Joint policy statement. Red Reflex Examination in Neonates, Infants, and Children (Pediatrics 2008;122:1401-4). Available at: http://aappolicy.aappublications.org/cgi/reprint/pediatrics.122/6/1401.pdf This policy is a revision of the policy posted on May 1, 2002.	Neonates, infants, and children	Before discharge from the neonatal nursery and during all subsequent routine health supervision visits	Red reflex

**Pediatric Eye Evaluations PPP:
Appendix 2. Policies for Vision Screening in Children**

TABLE A2-1 SUMMARY OF RECOMMENDATIONS FOR VISION SCREENING IN CHILDREN (CONTINUED)

Organization	Document Title, Most Recent Update	Population	Frequency	Examination
American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus	Vision Screening for Infants and Children, 2007.	Birth to 3 years	At every health supervision visit	External inspection Red reflex examination
		3 to 5 years	As soon as possible (no later than age 5 years)	Age-appropriate visual acuity measurement Ocular motility assessment Photostrengthening may be useful
		School-aged children	Routine school checks as determined locally	Not specified
U.S. Preventive Services Task Force (USPTSF)	Vision Strengthening for Children 1 to 5 Years of Age: U.S. Preventive Services Task Force Recommendation Statement (Pediatrics 2011;127:340-346).	Children younger than 3 years	No recommendation for screening: insufficient evidence	
		Children ages 3 to 5 years Provide vision screening: Grade B recommendation	One time	Visual acuity Stereovision Cover-uncover Hirschberg light reflex Autorefractometer Photostrengthening
American Academy of Pediatrics	Performing Preventive Services: A Bright Futures Handbook, 2010. (Alex Kemper, MD, MPH, MS, Monte A. Delmonte, MD, 155-7) http://brightfutures.aap.org/pdfs/AAP%20Bright%20Futures%20Periodicity%20Schedule%20101107.pdf	Newborn to 30 months	At all health supervision visits	Assess ability to fix and follow External inspection Ocular alignment and motility assessment: Hirschberg, cover-uncover, and cross-cover tests Pupillary examination Red reflex examination
		Age 3 years and older†	Annually through 6 years and then at ages 8, 10, 12, 15, 18 years	Monocular distance visual acuity with age- appropriate chart Ocular alignment and motility Stereovision Direct ophthalmoscopy Color vision

**Pediatric Eye Evaluations PPP:
Appendix 2. Policies for Vision Screening in Children**

TABLE A2-1 SUMMARY OF RECOMMENDATIONS FOR VISION SCREENING IN CHILDREN (CONTINUED)

Organization	Document Title, Most Recent Update	Population	Frequency	Examination
American Academy of Family Physicians	Summary of Recommendations for Clinical Preventive Services. Visual Impairment, Children, 2011. www.aafp.org	Children younger than 3 years	Current evidence is insufficient to assess the balance of benefits and harms of vision screening	
		Children 3 to 5 years	At least once	U.S. Preventive Services Task Force guidelines
National Association of School Nurses	Issue brief: School Nursing Services Role in Health Care. School Vision Screening, 2006. www.nasn.org	Young, at-risk, not previously screened	At least once during school life	Distance visual acuity Color vision Near visual acuity Binocular vision
		Older, previously screened	Periodic appraisal	Distance visual acuity
United States Department of Health and Human Services Administration for Children and Families (Head Start)	Head Start Program Performance Standard 1304.20 (b)(1): Child health and developmental services. Head Start Health Orientation Guide for Health Coordinators.	At enrollment: birth to school age	Within 45 days of enrollment	Snellen eye chart [‡] Near point screening [‡] 3-D screening [‡] Hirschberg [‡]
Prevent Blindness America	Guidelines for Children's Vision Health, 2004. www.preventblindnessflorida.org/children/child_position_statement.html	Newborns		General eye health assessment Red reflex test
		Birth to 2 years	At all health supervision visits	Vision evaluation
		Age 3 to 10 years	At all health supervision visits	Visual acuity Ocular alignment

TABLE A2-1 SUMMARY OF RECOMMENDATIONS FOR VISION SCREENING IN CHILDREN (CONTINUED)

Organization	Document Title, Most Recent Update	Population	Frequency	Examination
The Vision Council	<p>Making the Grade?, 2009.</p> <p>This document outlines the recommendations of vision screening/examination for public school children on a state-by-state basis.</p> <p>The Vision Council, 1700 Diagonal Road, Suite 500 Alexandria, VA 22314 703-548-4560</p> <p>www.thevisioncouncil.org</p>	Preschoolers and school-aged children	Recommendations vary by state	Recommendations vary by state

* At 3 to 4 years, rescreen within 4 to 6 months if child uncooperative; at 4 years and older, rescreen within 1 month.

† Rescreen within 6 months if child uncooperative.

‡ The tools are not endorsed by the Office of Head Start, but are used as examples of vision screening tools used in Head Start Programs.



APPENDIX 3. TECHNIQUES OF VISION SCREENING IN THE PRIMARY CARE AND COMMUNITY SETTING

RED REFLEX TEST

The red reflex test¹⁶² is properly performed by holding a direct ophthalmoscope close to the examiner's eye with the ophthalmoscope lens power set at "0." In a darkened room, the ophthalmoscope light should then be directed toward both eyes of the child simultaneously from a distance of approximately 18 to 30 inches (45 to 75 centimeters), and the lens power should be adjusted to ensure that the pupillary reflexes are sharply focused. A symmetric red reflex should be observed from both eyes for them to be considered normal. The red reflex varies based on retinal pigmentation and, thus, varies by race/ethnicity. Opacities in the red reflex, a markedly diminished reflex, the presence of a white or yellow reflex, or asymmetry of the reflexes (Brückner reflex) are all indications for referral to an ophthalmologist experienced in the examination of children. The exception to this rule is a transient opacity from mucus in the tear film that is mobile and completely disappears with blinking.

The See Red Card, a simple visual aid designed to help physicians who perform red reflex testing, can be ordered from the American Academy of Pediatrics (available at www2.aap.org/sforms/seered.htm).

EXTERNAL INSPECTION

The external inspection involves assessment of the eyelids, eyelashes, lacrimal apparatus, and orbit. The anatomy of the face (including the lids, interocular distance, and presence or absence of epicanthal folds), orbital rims, and presence of oculofacial anomalies should be noted. The position of the head and face (including head tilt or turn and chin-up or chin-down head posture) should be noted. Children who have prominent epicanthal folds and/or a wide, flat nasal bridge and normal binocular alignment often appear to have an esotropia (pseudoesotropia). Distinctive features unusual for the family may suggest the presence of a congenital anomaly and merit an assessment of other physical abnormalities (e.g., ears, hands).

PUPILLARY EXAMINATION

Pupils should be assessed for size, shape, symmetry, and response to light. To assess for a difference in pupil size, pupils should be observed in dim light. A difference of more than 1 millimeter may be clinically significant. Pupillary reactivity is observed by shining the light directly into each eye. The swinging-light test is used to assess for the presence of an afferent pupillary defect. In a darkened room, a penlight is shined in the right eye for less than 5 seconds with the child fixing on a distant target. The pupil should constrict. Next the light is brought quickly over the bridge of the nose to the left eye and the pupillary response is observed as for the right eye. The penlight is swung back and forth several times. A normal response is pupillary constriction or no change in pupil size. An abnormal response is pupillary dilation when the light is shined on the eye; that eye has an afferent pupil defect. An afferent pupil defect is usually a sign of a unilateral problem with the optic nerve, or other areas in the anterior visual pathway.

Pupillary evaluation in infants and children may be challenging due to frequent shifts in the patient's fixation and focusing.

FIX AND FOLLOW

The child's attention should be engaged using a developmentally appropriate target; such as a toy, the examiner or caregiver's face, or a hand-held light. The ability of the child to gaze steadily at the target should be observed. The target should be moved horizontally and vertically, and the child's ability to follow the target should be observed.

CORNEAL LIGHT REFLECTION

This test compares the position of the corneal light reflection in the two eyes. Encourage the child to fixate on a penlight from a distance of 12 inches (30 cm). Observe the positions of the two corneal reflexes. With normal corneal light reflection, symmetric reflexes are centered or slightly displaced nasally. If the eyes are misaligned, the reflexes will not be symmetric. If esotropia is present, one reflex will be temporally displaced. If exotropia is present, one reflex will be nasally displaced. If a vertical misalignment is present, one reflex will be displaced upward or downward.

COVER TEST

The cover test is a more accurate test for eye misalignment than the corneal light reflection test. It requires more cooperation on the part of the patient and more skill on the part of the examiner. While fixing on a distant or near target, the right eye is swiftly covered with an occluder as the left eye is observed for a refixation movement. The procedure is repeated with cover over the left eye. No eye movement of either eye indicates normal eye alignment. A refixation movement of either eye is indicative of strabismus. Maintaining adequate fixation throughout the test is key to successful testing; a hand-held or mounted attention-getting device is useful.

INSTRUMENT-BASED VISION-SCREENING METHODS

Instrument-based vision-screening techniques, such as photoscreening and autorefraction, are useful alternatives to visual acuity screening using eye charts for very young and developmentally delayed children and compare well with standard vision-testing techniques and cycloplegic refraction.^{65,70,77,128,163-165} They are not superior to quantitative visual acuity testing for children who are able to perform those tests. Most instrument-based vision-screening methods detect the presence of risk factors for amblyopia, including strabismus, high or asymmetric refractive errors, media opacities (e.g., cataract), retinal abnormalities (e.g., retinoblastoma), and ptosis. Newer technology utilizing binocular retinal birefringence scanning detects amblyopia by determining the presence of an associated microstrabismus.¹⁶⁶ Instrument-based vision-screening technologies and guidelines are evolving (www.aapos.org/resources/health_care_provider_resources).

Photoscreening uses off-axis photography and photorefraction to evaluate refractive error by pupillary reflex crescents and alignment via the corneal light reflection (Hirschberg reflex), the binocular red reflex (Brückner) test, and crescentic dimensions. The images are interpreted by a central reading center or by computer. Autorefractive devices utilize optically automated skiascopy methods or wavefront technology to evaluate the refractive error of each eye. These data are analyzed on the basis of preset refractive error criteria to determine whether a child passes or fails a screening.

Referral criteria for instrument-based screening that detects amblyopia risk factors are specified by the manufacturer and vary by age. There is a trade-off in terms of false positives and false negatives when these techniques are used. The evaluator must know how to apply the technology properly and be familiar with the limitations of the test. The sensitivity and specificity of the instrument screening devices depend on the referral criteria utilized. Guidelines for a uniform set of amblyopia risk factors that should be detected by instrument-based screening are shown in Table A3-1.¹⁶⁷ Criteria that emphasize a high rate of detection of at-risk children (i.e., high sensitivity) can result in excessive over-referrals (low specificity), whereas minimization of over-referrals can result in missing at-risk children (low sensitivity).

TABLE A3-1 AMBLYOPIA RISK FACTORS TO BE DETECTED BY INSTRUMENT-BASED SCREENING

	Age 12–30 months	Age 31–48 months	Age ≥49 months
Hyperopia	>4.50 D	>4.00 D	>3.50 D
Astigmatism	>2.50 D	>2.50 D	>1.50 D
Anisometropia	>2.00 D	>2.00 D	>1.50 D
Media opacities*	◆	◆	◆
Manifest strabismus*	◆	◆	◆

SOURCE: Data from Donahue SP, Arnold R, Ruben J, et al. Revised guidelines for reporting results from studies of preschool vision screening. J AAPOS 2012;16:e4.

D = diopter

* Risk factor should be detected in all age groups indicated.



APPENDIX 4. VISUAL ACUITY TESTING CHARTS

The World Health Organization (WHO) and the National Academy of Sciences Committee on Vision have made similar recommendations about optotype choice and arrangement on visual acuity testing charts.^{93,117} Optotypes should be clear, standardized, of similar characteristics, and should not reflect a cultural bias. Each line should contain five optotypes. Spacing between the optotypes should be proportional: the horizontal spacing between individual optotypes should be equal to the size of the optotype and the vertical spacing between lines should be the height of the optotypes in the lower line. Optotype sizes should generally be presented in 0.1 logMAR decrements. This arrangement leads to an inverted pyramid design for wall charts.

Visual acuity testing charts used with children that meet these recommendations⁹³ include LEA Symbols (Good-Lite Co., Elgin, IL), Sloan letters,⁶ Sloan numerals, Tumbling E, and HOTV. The Snellen chart is less desirable because the individual letters are not of equal legibility and the spacing of the letters does not meet WHO/Committee on Vision standards.^{93,120-122}

Several symbol charts have serious limitations for young children. These include Allen figures,¹²³ the Lighthouse chart, and the Kindergarten Eye Chart.¹²⁴ In these charts, the optotypes are not standardized and are presented in a culturally biased fashion.⁹² Although the Tumbling E chart meets WHO/Committee on Vision recommendations, it is less desirable because it requires spatial orientation skills not mastered by all children. Other visual acuity charts are being developed to overcome these limitations, including the Handy Eye Chart and the Compact Reduced logMAR chart.^{168,169}

Table A4-1 lists details of design of visual acuity testing charts that are commonly used.

TABLE A4-1 VISUAL ACUITY TESTING CHARTS

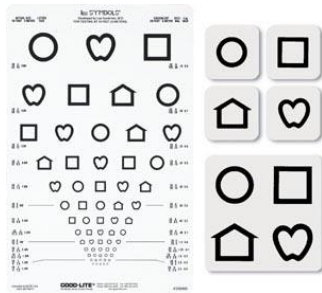


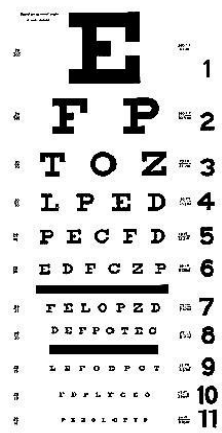
Chart	Meets WHO*/NAS† Recommendations	Attributes/Challenges
<p>LEA Symbols⁵</p>  <p>Reproduced with permission from Good-Lite Co., Elgin, IL.</p>	Yes	<p>Attributes:</p> <ul style="list-style-type: none"> ◆ Optotypes of similar legibility ◆ Inverted pyramid design with five optotypes per line (at visual acuities better than 20/100), proportional spacing between optotypes, and 0.1 LogMAR decrements in optotype size

TABLE A4-1 VISUAL ACUITY TESTING CHARTS (CONTINUED)

Chart	Meets WHO*/NAS† Recommendations	Attributes/Challenges
<p>Sloan Letters⁶</p>  <p>Reproduced with permission from Good-Lite Co., Elgin, IL.</p>	Yes†	<p>Attributes:</p> <ul style="list-style-type: none"> ◆ Optotypes of similar legibility ◆ Inverted pyramid design with five optotypes per line, proportional spacing between optotypes, and 0.1 LogMAR decrements in optotype size
<p>HOTV</p>  <p>Reproduced with permission from Good-Lite Co., Elgin, IL.</p>	Yes†	<p>Attributes:</p> <ul style="list-style-type: none"> ◆ Optotypes of similar legibility ◆ Inverted pyramid design with five optotypes per line, proportional spacing between optotypes, and 0.1 LogMAR decrements in optotype size
<p>Snellen Letters¹⁷⁰</p>  <p>Image is in the public domain.</p>	No	<p>Challenges:</p> <ul style="list-style-type: none"> • Optotypes are not of similar legibility • Variable number of optotypes per line • Nonproportional spacing between optotypes • Nonstandard optotype size decrements

**Pediatric Eye Evaluations PPP:
Appendix 4. Visual Acuity Testing Charts**

TABLE A4-1 VISUAL ACUITY TESTING CHARTS (CONTINUED)

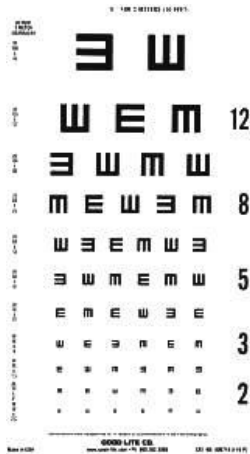
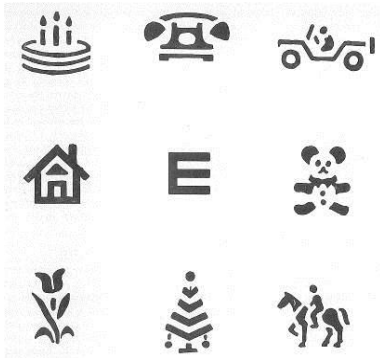
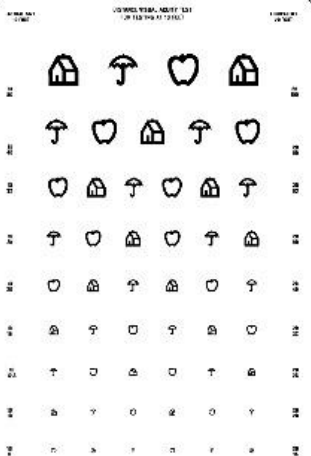

Chart	Meets WHO*/NAS† Recommendations	Attributes/Challenges
<p>Tumbling E Chart</p>  <p>Reproduced with permission from Good-Lite Co., Elgin, IL.</p>	Yes†	<p>Attributes:</p> <ul style="list-style-type: none"> ◆ Optotypes of similar legibility ◆ Inverted pyramid design available with five optotypes per line, proportional spacing between optotypes, and 0.1 LogMAR decrements in optotype size <p>Challenges:</p> <ul style="list-style-type: none"> • Requires spatial orientation skills not mastered by all children
<p>Allen Figures</p>  <p>Allen HF. A new picture series for preschool vision testing. Am J Ophthalmol 1975;44:40. Copyright 1957. Reprinted with permission from Elsevier. All rights reserved.</p>	No	<p>Challenges:</p> <ul style="list-style-type: none"> • Optotypes are not of similar legibility • Variable number of optotypes per line • Nonproportional spacing between optotypes • Nonstandard optotype size decrements • Optotypes not easily recognized by all children (e.g., telephone)

TABLE A4-1 VISUAL ACUITY TESTING CHARTS (CONTINUED)

Chart	Meets WHO*/NAS† Recommendations	Attributes/Challenges
<p>Lighthouse Chart</p>  <p>Reproduced with permission.</p>	No	<p>Challenges:</p> <ul style="list-style-type: none"> • Optotypes are not of similar legibility • Variable number of optotypes per line • Nonproportional spacing between optotypes • Nonstandard optotype size decrements
<p>Kindergarten Eye Chart</p>  <p>Reproduced with permission from Wilson Ophthalmic Corp., Mustang, OK.</p>	No	<p>Challenges:</p> <ul style="list-style-type: none"> • Optotypes are not of similar legibility • Variable number of optotypes per line • Nonproportional spacing between optotypes • Nonstandard optotype size decrements

NAS = National Academy of Sciences; WHO = World Health Organization

* World Health Organization. Consultation on development of standards for characterization of vision loss and visual functioning. Geneva, 4-5 September 2003. Available at: http://whqlibdoc.who.int/hq/2003/WHO_PBL_03.91.pdf. Accessed January 24, 2012.

† Committee on Vision. Recommended standard procedures for the clinical measurement and specification of visual acuity. Report of working group 39. Assembly of Behavioral and Social Sciences, National Research Council, National Academy of Sciences, Washington, D.C. *Adv Ophthalmol* 1980;41:103-48.

‡ Sloan, HOTV, and Tumbling E charts have chart designs that **do not** meet proportional spacing recommendations between individual optotypes and optotype lines.



SUGGESTED READING AND RESOURCES

- ◆ American Academy of Pediatrics Committee on Practice and Ambulatory Medicine and Section on Ophthalmology, American Association of Certified Orthoptists, American Association for Pediatric Ophthalmology and Strabismus, and American Academy of Ophthalmology. Policy Statement. Eye examination and vision screening in infants, children, and young adults by pediatricians. *Pediatrics* 2003;111:902-7. Reaffirmed May 2007. (Available at: <http://pediatrics.aappublications.org/content/111/4/902.full>. Accessed October 23, 2012.)
- ◆ American Academy of Pediatrics Section on Ophthalmology, Council on Children with Disabilities, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, American Association of Certified Orthoptists. Joint statement—learning disabilities, dyslexia, and vision. *Pediatrics*. 2009;124:837-44. (Available at: <http://pediatrics.aappublications.org/content/124/2/837.full> or <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.)
The companion document, Joint Technical Report – Learning Disabilities, Dyslexia, and Vision, is available at:
◆ Handler SM, Fierson WM, Section on Ophthalmology and Council on Children with Disabilities, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, and American Association of Certified Orthoptists. Joint technical report—learning disabilities, dyslexia, and vision. *Pediatrics* 2011;127:e818-56. (Available at: <http://pediatrics.aappublications.org/content/127/3/e818.long> or <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.)
- ◆ American Academy of Pediatrics Section on Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, American Academy of Ophthalmology, and American Association of Certified Orthoptists. Policy Statement. Red reflex examination in neonates, infants, and children. *Pediatrics* 2008;122:1401-4. (Available at: <http://pediatrics.aappublications.org/content/122/6/1401.full> or <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.)
- ◆ American Academy of Pediatrics Section on Ophthalmology and Committee on Practice and Ambulatory Medicine, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, and American Association of Certified Orthoptists. Policy Statement. Instrument-based pediatric vision screening. *Pediatrics* November 2012.
- ◆ American Academy of Pediatrics Sections on Endocrinology and Ophthalmology and American Association for Pediatric Ophthalmology and Strabismus. Clinical Report. Screening for retinopathy in the pediatric patient with type 1 diabetes mellitus. *Pediatrics* 2005;116:270-3. Reaffirmed January 2009. (Available at: <http://pediatrics.aappublications.org/content/116/1/270.full>. Accessed October 23, 2012.)
- ◆ American Academy of Pediatrics Sections on Rheumatology and Ophthalmology. Clinical Report. Ophthalmologic examinations in children with juvenile rheumatoid arthritis. *Pediatrics* 2006;117:1843-5. (Available at: <http://pediatrics.aappublications.org/content/117/5/1843.full>. Accessed October 23, 2012.)
- ◆ American Academy of Pediatrics. Pediatric Vision Screening Video: An Instructional Guide. 1999. Available at 847-434-4000 or https://www.nfaap.org/netforum/eWeb/dynamicpage.aspx?webcode=aapbks_productdetail&key=beee885a-85fd-4ee1-a1b2-8b147f4cb8e7. Accessed October 23, 2012.
- ◆ American Association for Pediatric Ophthalmology and Strabismus and American Academy of Ophthalmology. Joint Statement. Vision Screening for Infants and Children. 2007. Available at: <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.
- ◆ American Association for Pediatric Ophthalmology and Strabismus. Information for Patients on Vision Screening. Available at: www.aapos.org/terms/conditions/107. Accessed October 23, 2012.
- ◆ American Association for Pediatric Ophthalmology and Strabismus. Resources for School Nurses: Vision Screening Tutorial DVD. Available at: 415-561-8505 or www.aapos.org/ahp/resources_for_school_nurses/resources_for_school_nurses_2. Accessed October 23, 2012.
- ◆ Prevent Blindness America. Home Eye Tests for Children. Available at: www.preventblindness.org/home-eye-tests-children. Accessed October 23, 2012.
- ◆ Trobe JD. The Physician's Guide to Eye Care. 4th edition. San Francisco, CA: American Academy of Ophthalmology; 2012.



RELATED ACADEMY MATERIALS

Basic and Clinical Science Course

Pediatric Ophthalmology and Strabismus (Section 6, 2012–2013)

Clinical Statement

Abusive Head Trauma/Shaken Baby Syndrome (2010) (Free download available at: <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.)

Frequency of Ocular Examinations (2009) (Free download available at: <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.)

American Academy of Pediatrics Committee on Practice and Ambulatory Medicine and Section on Ophthalmology, American Association of Certified Orthoptists, American Association for Pediatric Ophthalmology and Strabismus, American Academy of Ophthalmology. Policy Statement. Eye examination in infants, children, and young adults by pediatricians. Pediatrics 2003;111:902-7. Reaffirmed May 2007. (Free download available at: <http://pediatrics.aappublications.org/content/111/4/902.full> or <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.)

American Academy of Pediatrics Section on Ophthalmology, Council on Children with Disabilities, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, American Association of Certified Orthoptists. Joint statement—learning disabilities, dyslexia, and vision. Pediatrics. 2009;124:837-44. (Free download available at: <http://pediatrics.aappublications.org/content/124/2/837.full> or <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.)

The companion document, Joint Technical Report – Learning Disabilities, Dyslexia, and Vision, is available at:

Handler SM, Fierson WM, Section on Ophthalmology and Council on Children with Disabilities, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, and American Association of Certified Orthoptists. Joint technical report—learning disabilities, dyslexia, and vision. Pediatrics 2011;127:e818-56. (Free download available at: <http://pediatrics.aappublications.org/content/127/3/e818.long> or <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.)

American Academy of Pediatrics Section on Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, American Academy of Ophthalmology, and American Association of Certified Orthoptists. Policy Statement. Red reflex examination in neonates, infants, and children. Pediatrics 2008;122:1401-4. (Free download available at: <http://pediatrics.aappublications.org/content/122/6/1401.full> or <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.)

American Academy of Pediatrics Section on Ophthalmology, American Academy of Ophthalmology, and American Association for Pediatric Ophthalmology and Strabismus. Policy Statement. Screening examination of premature infants for retinopathy of prematurity. Pediatrics 2006;117:572-6. (Free download available at: <http://pediatrics.aappublications.org/content/117/2/572.full> or <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.)

American Academy of Pediatrics Section on Ophthalmology and Committee on Practice and Ambulatory Medicine, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, and American Association of Certified Orthoptists. Policy Statement. Instrument-based pediatric vision screening. Pediatrics November 2012.

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REFERENCES

1. Scottish Intercollegiate Guidelines Network. Annex B: key to evidence statements and grades of recommendations. In: SIGN 50: A Guideline Developer's Handbook. Available at: www.sign.ac.uk/guidelines/fulltext/50/annexb.html. Accessed October 2, 2012.
2. Guyatt GH, Oxman AD, Vist GE, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ* 2008;336:924-6.
3. GRADE Working Group. Organizations that have endorsed or that are using GRADE. Available at: www.gradeworkinggroup.org/society/index.htm. Accessed October 21, 2011.
4. Vision in Preschoolers Study Group. Children unable to perform screening tests in vision in preschoolers study: proportion with ocular conditions and impact on measures of test accuracy. *Invest Ophthalmol Vis Sci* 2007;48:83-7.
5. Hyvarinen L, Nasanen R, Laurinen P. New visual acuity test for pre-school children. *Acta Ophthalmol (Copenh)* 1980;58:507-11.
6. Sloan LL. New test charts for the measurement of visual acuity at far and near distances. *Am J Ophthalmol* 1959;48:807-13.
7. Multi-ethnic Pediatric Eye Disease Study Group. Prevalence of amblyopia and strabismus in African American and Hispanic children ages 6 to 72 months: the Multi-ethnic Pediatric Eye Disease Study. *Ophthalmology* 2008;115:1229-36.
8. Joint Writing Committee for the Multi-ethnic Pediatric Eye Disease Study and the Baltimore Pediatric Eye Disease Study Groups. Risk factors associated with childhood strabismus: the Multi-ethnic Pediatric Eye Disease and Baltimore Pediatric Eye Disease Studies. *Ophthalmology* 2011;118:2251-61.
9. Matsuo T, Matsuo C. The prevalence of strabismus and amblyopia in Japanese elementary school children. *Ophthalmic Epidemiol* 2005;12:31-6.
10. Yu CB, Fan DS, Wong VW, et al. Changing patterns of strabismus: a decade of experience in Hong Kong. *Br J Ophthalmol* 2002;86:854-6.
11. Mohnney BG. Common forms of childhood esotropia. *Ophthalmology* 2001;108:805-9.
12. Wilson ME, Bluestein EC, Parks MM. Binocularity in accommodative esotropia. *J Pediatr Ophthalmol Strabismus* 1993;30:233-6.
13. Birch EE, Stager DR. Monocular acuity and stereopsis in infantile esotropia. *Invest Ophthalmol Vis Sci* 1985;26:1624-30.
14. Dickey CF, Metz HS, Stewart SA, Scott WE. The diagnosis of amblyopia in cross-fixation. *J Pediatr Ophthalmol Strabismus* 1991;28:171-5.
15. Dickey CF, Scott WE. The deterioration of accommodative esotropia: frequency, characteristics, and predictive factors. *J Pediatr Ophthalmol Strabismus* 1988;25:172-5.
16. Fawcett S, Leffler J, Birch EE. Factors influencing stereoacuity in accommodative esotropia. *J AAPOS* 2000;4:15-20.
17. American Academy of Ophthalmology Basic and Clinical Science Course Subcommittee. Basic and Clinical Science Course. Pediatric Ophthalmology and Strabismus: Section 6, 2012-2013. San Francisco, CA: American Academy of Ophthalmology; 2012:245.
18. Rahi JS, Dezateux C. Measuring and interpreting the incidence of congenital ocular anomalies: lessons from a national study of congenital cataract in the UK. *Invest Ophthalmol Vis Sci* 2001;42:1444-8.
19. Pi LH, Chen L, Liu Q, et al. Prevalence of eye diseases and causes of visual impairment in school-aged children in Western China. *J Epidemiol* 2012;22:37-44.
20. Good WV, Hardy RJ, Dobson V, et al. The incidence and course of retinopathy of prematurity: findings from the early treatment for retinopathy of prematurity study. *Pediatrics* 2005;116:15-23.
21. Aponte EP, Diehl N, Mohnney BG. Incidence and clinical characteristics of childhood glaucoma: a population-based study. *Arch Ophthalmol* 2010;128:478-82.
22. Papadopoulos M, Cable N, Rahi J, Khaw PT. The British Infantile and Childhood Glaucoma (BIG) Eye Study. *Invest Ophthalmol Vis Sci* 2007;48:4100-6.

Pediatric Eye Evaluations PPP: References

23. Pendergrass TW, Davis S. Incidence of retinoblastoma in the United States. *Arch Ophthalmol* 1980;98:1204-10.
24. Friedman DS, Repka MX, Katz J, et al. Prevalence of amblyopia and strabismus in white and African American children aged 6 through 71 months: the Baltimore Pediatric Eye Disease Study. *Ophthalmology* 2009;116:2128-34.
25. Giordano L, Friedman DS, Repka MX, et al. Prevalence of refractive error among preschool children in an urban population: the Baltimore Pediatric Eye Disease Study. *Ophthalmology* 2009;116:739-46.
26. Multi-ethnic Pediatric Eye Disease Study Group. Prevalence of myopia and hyperopia in 6- to 72-month-old African American and Hispanic children: the Multi-ethnic Pediatric Eye Disease Study. *Ophthalmology* 2010;117:140-7.
27. Multi-ethnic Pediatric Eye Disease Study Writing Committee. Prevalence of astigmatism in 6- to 72-month-old African American and Hispanic children: the Multi-ethnic Pediatric Eye Disease Study. *Ophthalmology* 2011;118:284-93.
28. Päivönsalo-Hietanen T, Tuominen J, Saari KM. Uveitis in children: population-based study in Finland. *Acta Ophthalmol Scand* 2000;78:84-8.
29. Pediatric Eye Disease Investigator Group. Randomized trial of treatment of amblyopia in children aged 7 to 17 years. *Arch Ophthalmol* 2005;123:437-47.
30. Pediatric Eye Disease Investigator Group. The clinical profile of moderate amblyopia in children younger than 7 years. *Arch Ophthalmol* 2002;120:281-7.
31. Thompson JR, Woodruff G, Hiscox FA, et al. The incidence and prevalence of amblyopia detected in childhood. *Public Health* 1991;105:455-62.
32. Donahue SP. Clinical practice. Pediatric strabismus. *N Engl J Med* 2007;356:1040-7.
33. van Hof-Van Duin J, Evenhuis-van Leunen A, Mohn G, et al. Effects of very low birth weight (VLBW) on visual development during the first year after term. *Early Hum Dev* 1989;20:255-66.
34. Repka M, Simons K, Kraker R. Laterality of amblyopia. *Am J Ophthalmol* 2010;150:270-4.
35. Pike MG, Holmstrom G, de Vries LS, et al. Patterns of visual impairment associated with lesions of the preterm infant brain. *Dev Med Child Neurol* 1994;36:849-62.
36. National Eye Institute: Visual Acuity Impairment Study Pilot Study. Bethesda, MD: Office of Biometry and Epidemiology, Department of Health and Human Services, The Institute;1984. NTIS Accession Number PB84 156173.
37. Agency for Healthcare Research and Quality. Evidence synthesis number 81. Screening for visual impairment in children ages 1–5 years: systematic review to update the 2004 U.S. Preventive Services Task Force Recommendation. Available at: www.uspreventiveservicestaskforce.org/uspstf11/vischildren/vischilides.pdf. Accessed October 31, 2011.
38. Kemper AR, Bruckman D, Freed GL. Prevalence and distribution of corrective lenses among school-age children. *Optom Vis Sci* 2004;81:7-10.
39. Multi-ethnic Pediatric Eye Disease Study and the Baltimore Pediatric Eye Disease Study Groups. Risk factors for astigmatism in preschool children: the Multi-ethnic Pediatric Eye Disease and Baltimore Pediatric Eye Disease Studies. *Ophthalmology* 2011;118:1974-81.
40. Gunn DJ, Cartwright DW, Gole GA. Incidence of retinopathy of prematurity in extremely premature infants over an 18-year period. *Clin Experiment Ophthalmol* 2012;40:93-9.
41. Ziylan S, Serin D, Karslioglu S. Myopia in preterm children at 12 to 24 months of age. *J Pediatr Ophthalmol Strabismus* 2006;43:152-6.
42. Ton Y, Wysesbeek YS, Spierer A. Refractive error in premature infants. *J AAPOS* 2004;8:534-8.
43. Repka MX. Ophthalmological problems of the premature infant. *Ment Retard Dev Disabil Res Rev* 2002;8:249-57.
44. Rudanko SL, Fellman V, Laatikainen L. Visual impairment in children born prematurely from 1972 through 1989. *Ophthalmology* 2003;110:1639-45.
45. Lindqvist S, Skranes J, Eikenes L, et al. Visual function and white matter microstructure in very-low-birth-weight (VLBW) adolescents--a DTI study. *Vision Res* 2011;51:2063-70.
46. Saldır M, Sarici SU, Mutlu FM, et al. An analysis of neonatal risk factors associated with the development of ophthalmologic problems at infancy and early childhood: a study of premature infants born at or before 32 weeks of gestation. *J Pediatr Ophthalmol Strabismus* 2010;47:331-7.

47. Johnson S, Fawke J, Hennessy E, et al. Neurodevelopmental disability through 11 years of age in children born before 26 weeks of gestation. *Pediatrics* 2009;124:e249-57.
48. Bodeau-Livinec F, Surman G, Kaminski M, et al. Recent trends in visual impairment and blindness in the UK. *Arch Dis Child* 2007;92:1099-104.
49. Boonstra N, Limburg H, Tijmes N, et al. Changes in causes of low vision between 1988 and 2009 in a Dutch population of children. *Acta Ophthalmol* 2012;90:277-86.
50. Bunce C, Wormald R. Causes of blind certifications in England and Wales: April 1999-March 2000. *Eye (Lond)* 2008;22:905-11.
51. Cunningham ET, Jr. Uveitis in children. *Ocul Immunol Inflamm* 2000;8:251-61.
52. Smith JA, Mackensen F, Sen HN, et al. Epidemiology and course of disease in childhood uveitis. *Ophthalmology* 2009;116:1544-51.
53. Petersen E, Kijlstra A, Stanford M. Epidemiology of ocular toxoplasmosis. *Ocul Immunol Inflamm* 2012;20:68-75.
54. Couser NL, Smith-Marshall J. The Washington Metropolitan pediatric vision screening quality control assessment. *ISRN Ophthalmology* 2011;2011:1-5.
55. Wilson J, Jungner G. Principles and Practice of Screening for Disease. Geneva, Switzerland: World Health Organization; 1968. Public Health Papers No. 34. Available at: http://whqlibdoc.who.int/php/WHO_PHP_34.pdf. Accessed October 25, 2011.
56. Kemper AR, Helfrich A, Talbot J, Patel N. Outcomes of an elementary school-based vision screening program in north Carolina. *J Sch Nurs* 2012;28:24-30.
57. Kvarnstrom G, Jakobsson P, Lennerstrand G. Visual screening of Swedish children: an ophthalmological evaluation. *Acta Ophthalmol Scand* 2001;79:240-4.
58. Chou R, Dana T, Bougatsos C. Screening for visual impairment in children ages 1-5 years: update for the USPSTF. *Pediatrics* 2011;127:e442-79. Available at: www.uspreventiveservicestaskforce.org/uspstf11/vischildren/vischildart.pdf. Accessed October 31, 2011.
59. Ehrlich MI, Reinecke RD, Simons K. Preschool vision screening for amblyopia and strabismus: programs, methods, guidelines, 1983. *Surv Ophthalmol* 1983;28:145-63.
60. Lithander J, Sjostrand J. Anisometropic and strabismic amblyopia in the age group 2 years and above: a prospective study of the results of treatment. *Br J Ophthalmol* 1991;75:111-6.
61. Arnold RW, Armitage MD, Gionet EG, et al. The cost and yield of photoscreening: impact of photoscreening on overall pediatric ophthalmic costs. *J Pediatr Ophthalmol Strabismus* 2005;42:103-11.
62. Kerr NC, Arnold RW. Vision screening for children: current trends, technology, and legislative issues. *Curr Opin Ophthalmol* 2004;15:454-9.
63. Arnold RW, Donahue SP. Compared value of amblyopia detection. *Binocul Vis Strabismus Q* 2006;21:78.
64. Kvarnstrom G, Jakobsson P, Lennerstrand G, Dahlgaard J. Preventable vision loss in children: a public health concern? *Am Orthopt J* 2006;56:3-6.
65. Joish VN, Malone DC, Miller JM. A cost-benefit analysis of vision screening methods for preschoolers and school-age children. *J AAPOS* 2003;7:283-90.
66. Kvarnstrom G, Jakobsson P, Lennerstrand G. Screening for visual and ocular disorders in children, evaluation of the system in Sweden. *Acta Paediatr* 1998;87:1173-9.
67. Morrison AS. Screening. In: Rothman KJ, Greenland S, eds. *Modern Epidemiology*, 2nd ed. Philadelphia, PA: Lippincott-Raven Publishers; 1998:510.
68. American Academy of Pediatrics Committee on Practice and Ambulatory Medicine and Section on Ophthalmology, American Association of Certified Orthoptists, American Association for Pediatric Ophthalmology and Strabismus, and American Academy of Ophthalmology. Eye examination in infants, children, and young adults by pediatricians. *Pediatrics* 2003;111:902-7. Available at: <http://pediatrics.aappublications.org/content/111/4/902.full>. Accessed October 23, 2012.
69. American Association for Pediatric Ophthalmology and Strabismus and American Academy of Ophthalmology. Joint Policy Statement. Vision Screening for Infants and Children. San Francisco, CA: American Academy of Ophthalmology; 2007. Available at: <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012

Pediatric Eye Evaluations PPP: References

70. U.S. Preventive Services Task Force. Recommendation Statement. Vision Screening for Children 1 to 5 Years of Age. Rockville, MD: U.S. Preventive Services Task Force; January 2011. AHRQ Publication No. 11-05151-EF-2. Available at: www.uspreventiveservicestaskforce.org/uspstf11/vischildren/vischildrs.htm. Accessed October 25, 2011.
71. U.S. Preventive Services Task Force. Vision screening for children 1 to 5 years of age: U.S. Preventive Services Task Force Recommendation statement. *Pediatrics* 2011;127:340-6.
72. Powell C, Hatt SR. Vision screening for amblyopia in childhood. *Cochrane Database of Syst Rev* 2009, Issue 3. Art. No.: CD005020. DOI: 10.1002/14651858.CD005020.pub3.
73. Donahue SP, Ruben JB. US Preventive Services Task Force vision screening recommendations. *Pediatrics* 2011;127:569-70.
74. Couser NL, Esmail FQ, Hutchinson AK. Vision screening in the pediatrician's office. *Open Journal of Ophthalmology* 2012;2:9-13.
75. Schmucker C, Grosselfinger R, Riemsma R, et al. Effectiveness of screening preschool children for amblyopia: a systematic review. *BMC Ophthalmol* 2009;9:3.
76. Carlton J, Karnon J, Czoski-Murray C, et al. 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:iii, xi-194.
77. Vision in Preschoolers Study Group. Comparison of preschool vision screening tests as administered by licensed eye care professionals in the Vision In Preschoolers Study. *Ophthalmology* 2004;111:637-50.
78. Pediatric Eye Disease Investigator Group. A randomized trial to evaluate 2 hours of daily patching for strabismic and anisometropic amblyopia in children. *Ophthalmology* 2006;113:904-12.
79. Chia EM, Mitchell P, Rochtchina E, et al. Unilateral visual impairment and health related quality of life: the Blue Mountains Eye Study. *Br J Ophthalmol* 2003;87:392-5.
80. Multi-ethnic Pediatric Eye Disease Study Group. General health-related quality of life in preschool children with strabismus or amblyopia. *Ophthalmology* 2011;118:574-80.
81. Eibschitz-Tsimhoni M, Friedman T, Naor J, et al. Early screening for amblyogenic risk factors lowers the prevalence and severity of amblyopia. *J AAPOS* 2000;4:194-9.
82. Pediatric Eye Disease Investigator Group. A randomized trial of atropine vs patching for treatment of moderate amblyopia: follow-up at age 10 years. *Arch Ophthalmol* 2008;126:1039-44.
83. American Academy of Ophthalmology Pediatric Ophthalmology/Strabismus Panel. Preferred Practice Pattern® Guidelines. Amblyopia. San Francisco, CA: American Academy of Ophthalmology; 2012. Available at: www.aao.org/ppp.
84. Colburn JD, Morrison DG, Estes RL, et al. Longitudinal follow-up of hypermetropic children identified during preschool vision screening. *J AAPOS* 2010;14:211-5.
85. Pediatric Eye Disease Investigator Group. Effect of age on response to amblyopia treatment in children. *Arch Ophthalmol* 2011;129:1451-7.
86. Chua B, Mitchell P. Consequences of amblyopia on education, occupation, and long term vision loss. *Br J Ophthalmol* 2004;88:1119-21.
87. Schmucker C, Kleijnen J, Grosselfinger R, et al. Effectiveness of early in comparison to late(r) treatment in children with amblyopia or its risk factors: a systematic review. *Ophthalmic Epidemiol* 2010;17:7-17.
88. Wilson ME. Adult amblyopia reversed by contralateral cataract formation. *J Pediatr Ophthalmol Strabismus* 1992;29:100-2.
89. Packwood EA, Cruz OA, Rychwalski PJ, Keech RV. The psychosocial effects of amblyopia study. *J AAPOS* 1999;3:15-7.
90. American Academy of Pediatrics. Policy Statement. Instrument-based Pediatric Vision Screening. *Pediatrics* November 2012.
91. Vision in Preschoolers Study Group. Preschool vision screening tests administered by nurse screeners compared with lay screeners in the vision in preschoolers study. *Invest Ophthalmol Vis Sci* 2005;46:2639-48.
92. Chaplin PK, Bradford GE. A historical review of distance vision screening eye charts: what to toss, what to keep, and what to replace. *NASN Sch Nurse* 2011;26:221-8.

93. World Health Organization. Consultation on development of standards for characterization of vision loss and visual functioning. Geneva, 4-5 September 2003. Available at: http://whqlibdoc.who.int/hq/2003/WHO_PBL_03.91.pdf. Accessed January 24, 2012.
94. Kemper A, Delmonte MA. Vision. In: Tanski S, Garfunkel LC, Duncan PM, Weitzman M, eds. *Performing Preventive Services: A Bright Futures Handbook*. Elk Grove Village, IL: American Academy of Pediatrics; 2010:155-7. Available at: <http://brightfutures.aap.org/pdfs/AAP%20Bright%20Futures%20Periodicity%20Sched%20101107.pdf>. Accessed February 29, 2012.
95. Wallace DK. Mandating comprehensive eye examinations for children: where is the evidence? *Ophthalmology* 2008;115:1271-2.
96. Bull MJ. Committee on Genetics. Health supervision for children with Down syndrome. *Pediatrics* 2011;128:393-406. Available at: http://aappolicy.aappublications.org/clinical_report/index.dtl. Accessed January 24, 2012.
97. Hersh JH. Committee on Genetics. Health supervision for children with neurofibromatosis. *Pediatrics* 2008;121:633-42. Available at: http://aappolicy.aappublications.org/clinical_report/index.dtl. Accessed January 24, 2012.
98. Cassidy J, Kivlin J, Lindsley C, Nocton J. Section on Rheumatology and the Section on Ophthalmology. Ophthalmologic examinations in children with juvenile rheumatoid arthritis. *Pediatrics* 2006;117:1843-5. Available at: http://aappolicy.aappublications.org/clinical_report/index.dtl. Accessed January 23, 2012.
99. American Academy of Pediatrics Committee on Genetics. Health care supervision for children with Williams syndrome. *Pediatrics* 2001;107:1192-204. Available at: <http://pediatrics.aappublications.org/content/107/5/full>. Accessed October 23, 2012.
100. American Academy of Pediatrics Committee on Genetics. Health supervision for children with Marfan syndrome. *Pediatrics* 1996;98:978-82. Available at: <http://pediatrics.aappublications.org/content/98/5/abstract>. Accessed October 23, 2012.
101. American Academy of Pediatrics Section on Hematology/Oncology and the Committee on Genetics. Health supervision for children with sickle cell disease. *Pediatrics* 2002;109:526-35. Available at: <http://pediatrics.aappublications.org/content/109/3/526.full>. Accessed October 23, 2012.
102. Lueder GT, Silverstein J. Section on Ophthalmology and Section on Endocrinology. Screening for retinopathy in the pediatric patient with type 1 diabetes mellitus. *Pediatrics* 2005;116:270-3. Reaffirmed October 2008. Available at: <http://aappolicy.aappublications.org/cgi/content/full/pediatrics;116/1/270>. Accessed January 27, 2012.
103. American Academy of Ophthalmology. Clinical Report. Screening for Retinopathy in the Pediatric Patient with Type 1 Diabetes Mellitus. San Francisco, CA: American Academy of Ophthalmology; 2005. Reaffirmed October 2008. Available at: <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.
104. Hersh JH, Saul RA. Committee on Genetics. Health supervision for children with fragile X syndrome. *Pediatrics* 2011;127:994-1006. Available at: http://aappolicy.aappublications.org/clinical_report/index.dtl. Accessed January 24, 2012.
105. American Academy of Pediatrics Section on Ophthalmology, Council on Children with Disabilities, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, American Association of Certified Orthoptists. Joint statement—learning disabilities, dyslexia, and vision. *Pediatrics* 2009;124:837-44. Available at: <http://pediatrics.aappublications.org/content/124/2/837.full> or <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.
106. Handler SM, Fierson WM. Section on Ophthalmology and Council on Children with Disabilities, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, and American Association of Certified Orthoptists. Joint technical report—learning disabilities, dyslexia, and vision. *Pediatrics* 2011;127:e818-56. Available at: <http://pediatrics.aappublications.org/content/127/3/e818.long>. Accessed October 23, 2012.

Pediatric Eye Evaluations PPP: References

107. Lawrence L, Wilson ME. Pediatric low vision. In: Wilson ME, Saunders RA, Trivedi RH, eds. *Pediatric Ophthalmology: Current Thought and a Practical Guide*. Berlin, Germany: Springer-Verlag; 2009:461-70.
108. American Association for Pediatric Ophthalmology and Strabismus. Policy Statement. Refractions in Children. San Francisco, CA: American Association for Pediatric Ophthalmology and Strabismus; 2012. Available at: http://www.aapos.org/client_data/files/2012/502_refractions_in_children_approved05.09.12.pdf. Accessed October 23, 2012.
109. American Academy of Ophthalmology Basic and Clinical Science Course Subcommittee. Basic and Clinical Science Course. *Pediatric Ophthalmology and Strabismus: Section 6, 2012-2013*. San Francisco, CA: American Academy of Ophthalmology; 2012:86-7.
110. Procianny L, Procianny E. The accuracy of binocular fixation preference for the diagnosis of strabismic amblyopia. *J AAPOS* 2010;14:205-10.
111. Sener EC, Mocan MC, Gedik S, et al. The reliability of grading the fixation preference test for the assessment of interocular visual acuity differences in patients with strabismus. *J AAPOS* 2002;6:191-4.
112. Wright KW, Walonker F, Edelman P. 10-diopter fixation test for amblyopia. *Arch Ophthalmol* 1981;99:1242-6.
113. Frank JW. The clinical usefulness of the induced tropia test for amblyopia. *Am Orthopt J* 1983;33:60-9.
114. Wallace DK. Tests of fixation preference for amblyopia. *Am Orthopt J* 2005;55:76-81.
115. Morale SE, Hughbanks-Wheaton DK, Cheng C, et al. Visual acuity assessment of children with special needs. *Am Orthopt J* 2012;62:90-8.
116. Cyert L, Schmidt P, Maguire M, et al. Vision in Preschoolers (VIP) Study Group. Threshold visual acuity testing of preschool children using the crowded HOTV and Lea Symbols acuity tests. *J AAPOS* 2003;7:396-9.
117. Committee on Vision. Recommended standard procedures for the clinical measurement and specification of visual acuity. Report of working group 39. Assembly of Behavioral and Social Sciences, National Research Council, National Academy of Sciences, Washington, D.C. *Adv Ophthalmol* 1980;41:103-48.
118. Candy TR, Mishoulam SR, Nosofsky RM, Dobson V. Adult discrimination performance for pediatric acuity test optotypes. *Invest Ophthalmol Vis Sci* 2011;52:4307-13.
119. Vision in Preschoolers (VIP) Study Group. Effect of age using Lea Symbols or HOTV for preschool vision screening. *Optom Vis Sci* 2010;87:87-95.
120. Bailey IL, Lovie JE. New design principles for visual acuity letter charts. *Am J Optom Physiol Opt* 1976;53:740-5.
121. McMonnies CW. Chart construction and letter legibility/readability. *Ophthalmic Physiol Opt* 1999;19:498-506.
122. McMonnies CW, Ho A. Letter legibility and chart equivalence. *Ophthalmic Physiol Opt* 2000;20:142-52.
123. Allen HF. A new picture series for preschool vision testing. *Am J Ophthalmol* 1957;44:38-41.
124. Hered RW, Murphy S, Clancy M. Comparison of the HOTV and Lea Symbols charts for preschool vision screening. *J Pediatr Ophthalmol Strabismus* 1997;34:24-8.
125. Rentschler I, Hiltz R, Brettel H. Spatial tuning properties in human amblyopia cannot explain the loss of optotype acuity. *Behav Brain Res* 1980;1:433-43.
126. Stager DR, Everett ME, Birch EE. Comparison of crowding bar and linear optotype acuity in amblyopia. *Am Orthopt J* 1990;40:51-6.
127. Youngson RM. Anomaly in visual acuity testing in children. *Br J Ophthalmol* 1975;59:168-70.
128. Ying GS, Kulp MT, Maguire M, et al. Sensitivity of screening tests for detecting vision in preschoolers-targeted vision disorders when specificity is 94%. *Optom Vis Sci* 2005;82:432-8.
129. Morad Y, Werker E, Nemet P. Visual acuity tests using chart, line, and single optotype in healthy and amblyopic children. *J AAPOS* 1999;3:94-7.
130. Saarela TP, Westheimer G, Herzog MH. The effect of spacing regularity on visual crowding. *J Vis* 2010;10:17.

131. Drover JR, Wyatt LM, Stager DR, Birch EE. The teller acuity cards are effective in detecting amblyopia. *Optom Vis Sci* 2009;86:755-9.
132. Friendly DS, Jaafar MS, Morillo DL. A comparative study of grating and recognition visual acuity testing in children with anisometropic amblyopia without strabismus. *Am J Ophthalmol* 1990;110:293-9.
133. Portnoy JZ, Thompson HS, Lennarson L, Corbett JJ. Pupillary defects in amblyopia. *Am J Ophthalmol* 1983;96:609-14.
134. Guyton DL, O'Connor GM. Dynamic retinoscopy. *Curr Opin Ophthalmol* 1991;2:78-80.
135. Hunter DG. Dynamic retinoscopy: the missing data. *Surv Ophthalmol* 2001;46:269-74.
136. Rosenbaum AL, Bateman JB, Bremer DL, Liu PY. Cycloplegic refraction in esotropic children. Cyclopentolate versus atropine. *Ophthalmology* 1981;88:1031-4.
137. Khoo BK, Koh A, Cheong P, Ho NK. Combination cyclopentolate and phenylephrine for mydriasis in premature infants with heavily pigmented irides. *J Pediatr Ophthalmol Strabismus* 2000;37:15-20.
138. Apt L, Henrick A. Pupillary dilatation with single eyedrop mydriatic combinations. *Am J Ophthalmol* 1980;89:553-9.
139. Goodman CR, Hunter DG, Repka MX. A randomized comparison study of drop versus spray topical cycloplegic application. *Binocul Vis Strabismus Q* 1999;14:107-10.
140. Ismail EE, Rouse MW, De Land PN. A comparison of drop instillation and spray application of 1% cyclopentolate hydrochloride. *Optom Vis Sci* 1994;71:235-41.
141. Wesson MD, Bartlett JD, Swiatocha J, Woolley T. Mydriatic efficacy of a cycloplegic spray in the pediatric population. *J Am Optom Assoc* 1993;64:637-40.
142. Seshadri J, Lakshminarayanan V. Screening efficiency of the Hardy-Rand-Rittler (HRR) colour test (4th edn). *J Mod Opt* 2007;54:1361-5.
143. National Center for Health Statistics. Color Vision Deficiencies in Youths 12-17 Years of Age. United States. *Vital Health Stat, Ser 11, DHEW Publ No. (HRA) 74-1616, No. 134*, 1974.
144. Gandhi NG, Prakalapakorn SG, El-Dairi MA, et al. Icare ONE rebound vs Goldmann applanation tonometry in children with known or suspected glaucoma. *Am J Ophthalmol* 2012;154:843-9.
145. Lambert SR, Melia M, Buffenn AN, et al. Rebound tonometry in children: a report by the American Academy of Ophthalmology. *Ophthalmology*. In press.
146. Lopes JE, Wilson RR, Alvim HS, et al. Central corneal thickness in pediatric glaucoma. *J Pediatr Ophthalmol Strabismus* 2007;44:112-7.
147. Tai TY, Mills MD, Beck AD, et al. Central corneal thickness and corneal diameter in patients with childhood glaucoma. *J Glaucoma* 2006;15:524-8.
148. Dai E, Gunderson CA. Pediatric central corneal thickness variation among major ethnic populations. *J AAPOS* 2006;10:22-5.
149. Pediatric Eye Disease Investigator Group. Central corneal thickness in children. *Arch Ophthalmol* 2011;129:1132-8.
150. American Academy of Ophthalmology Pediatric Ophthalmology/Strabismus Panel. Preferred Practice Pattern® Guidelines. Esotropia and Exotropia. San Francisco, CA: American Academy of Ophthalmology; 2012. Available at: www.aao.org/ppp.
151. Stone EM, Aldave AJ, Drack AV, et al. Recommendations for genetic testing of inherited eye diseases: report of the American Academy of Ophthalmology Task Force on Genetic Testing. *Ophthalmology*. In press.
152. American Academy of Ophthalmology Refractive Management/Intervention Panel. Preferred Practice Pattern® Guidelines. Refractive Errors & Refractive Surgery. San Francisco, CA: American Academy of Ophthalmology; 2012. Available at: www.aao.org/ppp.
153. Agency for Healthcare Research and Quality. Fact Sheet. Disparities in Children's health Care Quality: Selected Examples from the National Healthcare Quality and Disparities Reports, 2008. Rockville, MD: Agency for Healthcare Research and Quality; 2009. AHRQ Publication 09-0060. Available at: www.ahrq.gov/qual/nhqdr08/nhqdrchild08.pdf. Accessed January 25, 2012.
154. Kemper AR, Wallace DK, Patel N, Crews JE. Preschool vision testing by health providers in the United States: Findings from the 2006-2007 Medical Expenditure Panel Survey. *J AAPOS* 2011;15:480-3.

**Pediatric Eye Evaluations PPP:
References**

155. Flores G. Committee on Pediatric Research. Technical report--racial and ethnic disparities in the health and health care of children. *Pediatrics* 2010;125:e979-e1020.
156. Majeed M, Williams C, Northstone K, Ben-Shlomo Y. Are there inequities in the utilisation of childhood eye-care services in relation to socio-economic status? Evidence from the ALSPAC cohort. *Br J Ophthalmol* 2008;92:965-9.
157. Ganz M, Xuan Z, Hunter DG. Patterns of eye care use and expenditures among children with diagnosed eye conditions. *J AAPOS* 2007;11:480-7.
158. Donahue SP, Baker JD, Scott WE, et al. Lions Clubs International Foundation Core Four Photoscreening: results from 17 programs and 400,000 preschool children. *J AAPOS* 2006;10:44-8.
159. Kemper AR, Uren RL, Clark SJ. Barriers to follow-up eye care after preschool vision screening in the primary care setting: findings from a pilot study. *J AAPOS* 2006;10:476-8.
160. Kemper AR, Diaz G Jr, Clark SJ. Willingness of eye care practices to evaluate children and accept Medicaid. *Ambul Pediatr* 2004;4:303-7.
161. Ramsey JE, Bradford GE. Legislative issues facing pediatric ophthalmology in 2006. *Curr Opin Ophthalmol* 2006;17:441-6.
162. American Academy of Pediatrics Section on Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, American Academy of Ophthalmology, and American Association of Certified Orthoptists. Red reflex examination in neonates, infants, and children. *Pediatrics* 2008;122:1401-4. Available at: <http://pediatrics.aappublications.org/content/122/6/full> or <http://one.aao.org/CE/PracticeGuidelines/ClinicalStatements.aspx>. Accessed October 23, 2012.
163. Miller JM, Dobson V, Harvey EM, Sherrill DL. Comparison of preschool vision screening methods in a population with a high prevalence of astigmatism. *Invest Ophthalmol Vis Sci* 2001;42:917-24.
164. Salcido AA, Bradley J, Donahue SP. Predictive value of photoscreening and traditional screening of preschool children. *J AAPOS* 2005;9:114-20.
165. Arnold RW, Stark L, Leman R, et al. Tent photoscreening and patched HOTV visual acuity by school nurses: validation of the ASD-ABCD protocol. (Anchorage School District-Alaska Blind Child Discovery program). *Binocul Vis Strabismus Q* 2008;23:83-94.
166. Loudon SE, Rook CA, Nassif DS, et al. Rapid, high-accuracy detection of strabismus and amblyopia using the pediatric vision scanner. *Invest Ophthalmol Vis Sci* 2011;52:5043-8.
167. Donahue SP, Arnold RW, Ruben JB. Preschool vision screening: what should we be detecting and how should we report it? Uniform guidelines for reporting results of preschool vision screening studies. *J AAPOS* 2003;7:314-6.
168. Cromelin CH, Candy TR, Lynn MJ, et al. The Handy Eye Chart: a new visual acuity test for use in children. *Ophthalmology* 2012;119:2009-13.
169. Laidlaw DA, Abbott A, Rosser DA. Development of a clinically feasible logMAR alternative to the Snellen chart: performance of the "compact reduced logMAR" visual acuity chart in amblyopic children. *Br J Ophthalmol* 2003;87:1232-4.
170. Snellen H. On the methods of determining the acuity of vision. In: Norris WF, Oliver CA, eds. *System of Diseases of the Eye*. Philadelphia, PA: JB Lippincott Company; 1900:11-29.



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