EVIDENCE-BASED CLINICAL PRACTICE GUIDELINE

Comprehensive Pediatric Eye and Vision Examination

For Peer/Public Review May 16, 2016

AMERICAN OPTOMETRIC ASSOCIATION

OPTOMETRY: THE PRIMARY EYE CARE PROFESSION

The American Optometric Association represents the thousands of doctors of optometry throughout the United States who in a majority of communities are the only eye doctors. Doctors of optometry provide primary eye care to tens of millions of Americans annually.

Doctors of optometry (O.D.s/optometrists) are the independent primary health care professionals for the eye. Optometrists examine, diagnose, treat, and manage diseases, injuries, and disorders of the visual system, the eye, and associated structures, as well as identify related systemic conditions affecting the eye. Doctors of optometry prescribe medications, low vision rehabilitation, vision therapy, spectacle lenses, contact lenses, and perform certain surgical procedures.

The mission of the profession of optometry is to fulfill the vision and eye care needs of the public through clinical care, research, and education, all of which enhance quality of life.

Disclosure Statement

This Clinical Practice Guideline was funded by the American Optometric Association (AOA), without financial support from any commercial sources. The Evidence-Based Optometry Guideline Development Group and other guideline participants provided full written disclosure of conflicts of interest prior to each meeting and prior to voting on the strength of evidence or clinical recommendations contained within this guideline.

Disclaimer

Recommendations made in this guideline do not represent a standard of care. Instead, the recommendations are intended to assist the clinician in the decision-making process. Patient care and treatment should always be based on a clinician's independent professional judgment, given the patient's circumstances, and in compliance with state laws and regulations.

The information in this guideline is current to the extent possible as of the date of publication.

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Comprehensive Pediatric Eye and Vision Examination

Developed by the AOA Evidence-Based Optometry Guideline Development Group

Approved by the AOA Board of Trustees insert date

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A. What is the Evidence-Based Process?

As a result of the Medicare Improvement for Patients and Providers Act of 2008, Congress commissioned the Secretary of Health and Human Services to create a public-private program to develop and promote a common set of standards for the development of clinical practice guidelines (CPGs). These standards address the structure, process, reporting, and final products of systematic reviews of comparative effectiveness research and evidence-based clinical practice guidelines.

The Institute of Medicine (IOM), now the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine, in response to a request from the Agency for Healthcare Research and Quality (AHRQ), issued two reports in March 2011: *Clinical Practice Guidelines We Can Trust* and *Finding What Works in Health Care: Standards for Systematic Reviews.*

In *Clinical Practice Guidelines We Can Trust,*[1] the IOM redefined CPGs as follows:

"Clinical practice guidelines are statements that include recommendations intended to optimize patient care that are informed by a systematic review of the evidence and an assessment of the benefits and harms of alternative care options."

The report states that to be trustworthy, guidelines should:

- Be based on a systematic review of existing evidence
- Be developed by a knowledgeable, multidisciplinary panel of experts and key stakeholders
- Consider important patient subgroups and preferences, as appropriate
- Be based on a transparent process that minimizes conflicts of interest and biases
- Provide a clear explanation of the logical relationships between alternative care options and health outcomes
- Provide a grading of both the strength of quality of evidence and the strength of the clinical recommendation
- Be revised as appropriate when new evidence warrants modifications of recommendations.

Based on the IOM reports, the American Optometric Association (AOA) Evidence-Based Optometry (EBO) Committee developed a 14-step process to meet the new evidence-based recommendations for trustworthy guidelines.

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AOA's 14 Steps to Evidence-Based Clinical Practice Guideline Development	
1.	Guideline Development Group: Evidence–Based Optometry (EBO) Committee selects a multidisciplinary panel of experts, including patient and public representatives, for the Guideline Development Group (GDG).
2.	Transparency and COI: GDG manages all conflict of interest (COI), which is documented by AOA staff.
3.	Clinical Questions*: GDG explores and defines all clinical questions through a Question Formulation Meeting and defines search criteria.
4.	Search for Evidence: AOA Staff sends clinical questions for query (outside researchers) and provides all papers to the Guideline Development Reading Group (GDRG). There should be no inclusion of Systematic Review (SR) writers in the GDRG.
5.	Grade Evidence and Clinical Recommendations: Two clinicians from the GDRG read and grade papers, randomly selected according to the pre-designed evidence search criteria. They state clinical recommendation(s) from each paper and grade the strength of each.
6.	Articulate Clinical Recommendations*: GDRG reviews all clinical recommendations and articulates each for inclusion in the guideline during an "Articulation of Recommendations" meeting and identified gaps in medical research are documented
7.	Write Draft: AOA Staff sends the Articulation results to the writer for development of draft 1.
8.	Draft Review and Edits*: GDG reads draft 1, discusses and edits.
9.	Rewrite/Final Drafts: AOA Staff sends the draft results to the writer for writing/revisions for draft 2, then sends to medical editor for copy editing, then a final review is completed as necessary.
10.	Approval for Peer Review: AOA Staff or EBO Committee Chair sends the final draft to AOA Board of Trustees for approval to post for peer and public review. This draft is posted on the AOA website, the review period is announced, and comments are solicited.
11.	Final Document Produced: GDG reviews all peer review comments and revises the final document (includes peer review comments, documents why a peer review comment was not included, or identifies further gaps for review when preparing the next edition).
12.	Final Draft Approval and Legal Review: AOA Staff or EBO Committee Chair sends to the AOA Board of Trustees and AOA Legal Counsel for approval that the GDG followed the evidence-based process as outlined by the IOM and AOA EBO Committee (same management of COI).
13.	Post Guidelines: AOA Staff posts the evidence-based guideline to AOA website and submits it to the National Guideline Clearinghouse for public use, accompanied by AOA's written process and documents.
14.	Schedule Reviews: GDG reviews all previously identified gaps in medical research and any new evidence, and revises the evidence-based guideline every 2 to 5 years.

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290 **Denotes face-to-face meeting*
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B. How to Use This Guideline

The following table provides the grading system used in this guideline for rating evidence-based clinical statements. Grades are provided for both strength of the evidence and clinical recommendations.

Key to Strength of Evidence and Clinical Recommendation Grading

Strength of Evidence Levels

Grade	
A	Data derived from well-designed, randomized clinical trials (RCTs); systematic reviews; meta-analyses; or diagnostic studies (Grade A) of relevant populations with a validated reference standard. Grade A diagnostic studies do not have a narrow population or use a poor reference standard and are not case control studies of diseases or conditions.
B	Randomized clinical trials (RCTs) with weaker designs; cohort studies (retrospective or prospective); or diagnostic studies (Grade B). Grade B diagnostic studies have only one of the following: a narrow population, or the sample used does not reflect the population to whom the test would apply, or uses a poor reference standard, or the comparison between the test and reference standard is not blinded, or are case control studies of diseases or conditions.
C	Studies of strong design, but with substantial uncertainty about conclusions or serious doubts about generalizations, bias, research design, or sample size. Nonrandomized trials; case control studies (retrospective or prospective); or diagnostic studies (Grade C). Grade C diagnostic studies have at least 2 or more of the following: a narrow population, or the sample used does not reflect the population to whom the test would apply, or uses a poor reference standard, or the comparison between the test and reference standard is not blinded, or are case control studies of diseases or conditions.
D	Cross sectional studies; case reports/series; reviews; position papers; expert opinion; or reasoning from principal.

Clinical Recommendation Levels

Strong Recommendation: The benefits of the recommendation clearly exceed the harms (or the harms clearly exceed the benefits in the case of a negative recommendation) and the quality of evidence is excellent (Grade A or B). In some clearly identified circumstances, a strong recommendation may be made on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh the harms.

This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

Recommendation: The benefits of the recommendation exceed the harms (or the harms exceed the benefits in the case of a negative recommendation) but the quality of evidence is not as strong (Grade B or C). In some clearly identified circumstances, a recommendation may be made on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh the harms.

This recommendation should generally be followed, but remain alert for new information.

Option: The benefits of the recommendation exceed the harms (or the harms exceed the benefits in the case of a negative recommendation) but the quality of evidence is low (Grade D) or well-done studies (Grade A, B, or C) show little clear advantage of one approach versus another. In some clearly identified circumstances, an option may be elevated to a recommendation even with lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh the harms.

There should be an awareness of this recommendation, but a flexibility in clinical decision-making as well as remaining alert for new information.

Clinical Notes and Statements

Strength of evidence grades (A, B, C, or D) are shown throughout the guideline for clinical notes and statements. For example, a clinical note or statement with a strength of evidence grade of "B" is shown as "(Evidence Grade: B)".

Evidence-Based Action Statements will be highlighted in an "Action" box, with the strength of evidence, level of confidence, and clinical recommendation grading information listed. For example:

EVIDENCE-BASED ACTION STATEMENT: Parents/caregivers and children should be educated about potential risks for eye injuries at home, at school, and during sports and recreational activities and advised ~~them~~ about safety precautions to decrease the risk of ocular injury.[177,183] Prevention of eye injuries in children should focus on the use of protective eyewear, parental supervision, and on education about both the risks of eye injury and the benefits of protective eyewear.[178]
Evidence Quality: Grade B: Retrospective cohort studies **Level of Confidence**: Medium **Clinical Recommendation Level**: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.
Evidence Statements: It is important to discuss eye safety issues with children/ parents/ caregivers.[177] (Evidence Grade: B)[183] (Evidence Grade: B) Prevention strategies should focus on the use of protective eyewear, parental supervision, and on childhood education about both the risks of eye injury and the utility of protective eyewear.[178] (Evidence Grade: B)
Potential Benefits: Reduction in eye injuries in children. / **Potential Risks/Harms**: None
Benefit and Harm Assessment: Benefits significantly outweigh harms.
Potential Costs: Direct cost of counseling as part of a pediatric eye and vision examination.
Value Judgments: None
Role of Patient Preferences: None
Intentional Vagueness: Specific type/form of counseling is not stated, as it is patient specific.
Gaps in Evidence: None

The Action Statement profile provides additional information related to the development and implementation of the clinical recommendation. The following is an explanation of the categories listed in the profile:

Evidence Quality – The strength of evidence grade (A, B, C, D) or the aggregate strength of evidence grade (if multiple studies were available for review) and the type/method of research study or studies reviewed.

Level of Confidence – The consistency of the evidence and the extent to which it can be trusted specified as high, medium or low.

Clinical Recommendation Level – The grade (Strong Recommendation, Recommendation, or Option) assigned to the implementation of the clinical recommendation made in the Action Statement.

Evidence Statements – The clinical statements derived from research studies reviewed that support the Action Statement.

Potential Benefits – Favorable changes which would likely occur if the Action Statement was followed.

Potential Risks/Harms – Adverse effects or unfavorable outcomes that may occur if the Action Statement was followed.

Benefit and Harm Assessment – A comparison of the relationship of benefits to harms specified as "benefits significantly outweigh harms" (or vice versa) or a "balance of benefits and harms."

Potential Costs – Direct and indirect costs refer to the costs of the procedure, test, or medication; time spent counseling the patient; administrative time; etc.

Value Judgments – Determinations made by the Guideline Development Group in the development of the Action Statement relating to guiding principles, ethical considerations, or other priorities.

Role of Patient Preference – The role the patient has in shared decision making regarding implementation of the Action Statement specified as large, moderate, small, or none.

Intentional Vagueness – Specific aspects of the Action Statement that are left vague due to factors such as the role of clinical judgment, patient variability, concerns over setting legal precedent, etc.

Gaps in Evidence – Areas identified during searches and evaluations of the research that show gaps in available evidence.

Consensus-Based Action Statements, based on consensus by the Guideline Development Reading Group, are also highlighted in an "Action" box, but without any strength of evidence or clinical recommendation grading information listed. For example:

CONSENSUS-BASED ACTION STATEMENT: At the conclusion of a comprehensive pediatric eye and vision examination, the diagnosis should be explained to the patient/parent/caregiver and related to the patient's symptoms, and treatment plans and prognosis discussed.
Evidence Quality: There is a lack of published research to support or refute the use of this recommendation.
Benefit and Harm Assessment: Implementation of this recommendation is likely to increase patient/parent/caregiver understanding of any diagnosed eye or vision problems and improve compliance with any recommended treatment. The benefits of this recommendation were established by expert consensus opinion.

I. INTRODUCTION

An estimated one in three preschool children[2-5] and one in four school-age children[6] in the United States has a vision problem, and these problems are reported to occur at an even higher rate in children living in poor urban environments.[7,8] Uncorrected eye and vision problems can become worse over time. Early diagnosis and treatment are essential to optimize children's eye health and vision and to prevent vision loss.

Eye and vision disorders can lead to problems in a child's normal development,[9,10] school performance, [8,11-14] social interactions,[15] and self-esteem.[15-17] Vision disorders that occur in childhood may manifest as problems well into adulthood affecting an individual's level of education, employment opportunities, and social interactions.[18]

Early recognition of visual disorders is especially important in children with developmental and intellectual disabilities.[19,20] Children with disabilities (e.g., Autism Spectrum Disorder, Cerebral Palsy, Down Syndrome, Fragile X Syndrome, hearing impairment) are reported to have significantly more eye and vision problems (e.g., strabismus, refractive errors, nystagmus) than children without these disabilities.[20-25] The increasing severity of the disability is related to a higher prevalence of vision problems.[20]

This Evidence-Based Clinical Practice Guideline for the Comprehensive Pediatric Eye and Vision Examination describes procedures for evaluation of the eye health and vision status of infants and children. It contains recommendations for timely diagnosis and, when necessary, referral for consultation with, or treatment by, another health care provider. Other guidelines developed to address treatment of specific eye and vision conditions can be found at *AOA Clinical Practice Guidelines web page*.

The recommendations in this guideline were developed to assist eye doctors (optometrists and ophthalmologists) involved in providing eye and vision examinations for infants and children. Others who assist in providing coordinated patient care for specific services, as well as patients and caregivers, may also gain insight from this document.

A. Guideline Objectives

This Guideline can help achieve the following objectives:

- Recommend an optimal timetable for comprehensive eye and vision examinations for infants and children (newborn to 18 years of age)
- Select appropriate examination procedures for infants and children
- Effectively examine the eye health, vision status, and ocular manifestations of systemic disease of infants and children
- Minimize or avoid the adverse effects of eye and vision problems in infants and children through prevention, education, early diagnosis, treatment, and management
- Inform and educate patients, parents/caregivers, and other health care providers about the importance of eye health and good vision, and the need for and frequency of pediatric eye and vision examinations.

II. BACKGROUND

A. Visual Development

Development of the visual system is incomplete at birth.[26] Basic visual functions develop rapidly during the first year of life. By 6 months of age, vision has become the dominant sense and forms the basis for perceptual, cognitive, and social development;[27] however, maturation of the visual system continues for several years.

Objective testing (visual evoked response) demonstrates that the visual cortex is capable of achieving 20/20 visual acuity by 6 months of age; however, the ability of a child to respond to subjective visual acuity tests is influenced by verbal and cognitive development. Thus, for some children, it may not be possible to elicit 20/20 visual acuity until after 5 years of age. Stereopsis first appears at 3 to 4 months of age and continues to develop through the first two years of life.[28] Mature accommodative behavior is present at 5 to 24 months of age.[29] Development of accommodative facility, eye movements, and visual information processing continues in the preschool and school-age years.[30-32]

During the first few years of life, the visual system is highly susceptible to deprivation from blurred images or obstruction of vision. Blurred visual input (e.g., due to congenital cataracts, misaligned eyes, and high amounts of or significant differences in refractive error between the eyes) may lead to serious lifelong effects on vision. In addition, obstructive visual deprivation can be caused by, but not limited to, ocular and systemic anomalies such as ptosis, glaucoma, cataracts, trauma, infections, and tumors.

B. Epidemiology of Eye and Vision Disorders in Children

There are many visual conditions and ocular or systemic diseases, which may occur in childhood that can affect visual development. Among the eye and vision disorders experienced by infants and children are:

- **Refractive errors**

Uncorrected refractive errors (hyperopia, myopia, and astigmatism) are the most common cause of reduced vision in children.[33] Hyperopia has a high prevalence among young children, with over 20% estimated to have ≥2.00 diopters (D).[33,34] Significant hyperopia (≥2.00 D) is commonly found in association with the development of strabismus and amblyopia.[3,35]

Myopia generally develops in children during their early school years and increases in magnitude, as they get older. The age at onset typically ranges from 7 to 16 years. In the Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error Study (CLEERE), one in six children ages 5 to 17 (Asian, Hispanic, African American and White) developed myopia during their school-age years.[36] More than 75% of the new cases of myopia occurred between the ages of 9 and 13.

Among school-age children, myopia has been increasing in recent years and developing at a younger age.[36,37] The National Health and Nutrition Examination Survey results for 12 to 17 year olds show the prevalence of myopia has increased from 24 percent in 1971-72 to 33.9 percent in 1999-2004.[38] High levels of myopia can contribute to the development of lattice degeneration; retinal holes, tears, or detachment; cataracts; and glaucoma.[39]

Astigmatism up to 2.00 D is common in children under 3 years of age. Studies show that 30 to 50 percent of infants less than 12 months of age have significant astigmatism (≥1.00 D), which declines over the first few years of life, becoming stable by approximately 2 1/2 to 5 years of age.[40,41]

A difference in the amount of refractive error between the eyes (anisometropia) of 1.00 D or more is considered clinically significant. There is a low prevalence (4 percent) of anisometropia before 6 years of age;[42] however, it has been shown to increase to nearly 6 percent at 12 to 15 years of age.[43]

Infantile anisometropia can be transient and may disappear. Severe anisometropia (≥3.00D) may persist and is likely to lead to the development of amblyopia during the preschool years.[44]

Estimates of refractive errors in children 6 months to 72 months (6 years) of age are shown in Table 1.

Table 1: Prevalence of Refractive Errors in Children 6 Months to 72 Months (6 Years) of Age

Condition	Non-Hispanic White	Hispanic	African American	Asian
Myopia				
≤1.00D spherical equivalent (SE)	1.20%	3.7%	6.6%	3.98%
≥1.00D SE	0.70%		5.5%	
Hyperopia				
≥2.00D SE	25.65%	26.9%	20.8%	13.47%
≥3.00D SE	8.9%		4.4%	
Astigmatism				
≥1.50D cylindrical refractive error	6.33%	16.8%	12.7%	8.29%
≥3.00D cylindrical refractive error		2.9%	1.0%	
Anisometropia				
≥1.00D SE		4.3%	4.2%	

Source: *Multi-Ethnic Pediatric Eye Disease Study*[33, 34, 42, 45] and the *Baltimore Pediatric Eye Disease Study*[46]

In the school-based CLEERE study of children 5 to 17 years of age, overall 9.2 percent of the children were myopic, 12.8 percent were hyperopic, and 28.4 percent had astigmatism. (Table 2)

Table 2: Prevalence of Refractive Errors in Children 5 to 17 Years of Age

Condition	Non-Hispanic White	Hispanic	African American	Asian
Myopia				
≥0.75D in each principal meridian	4.4%	13.2%	6.6%	18.5%
Hyperopia				
≥1.25D in each principal meridian	19.3%	12.7%	6.4%	6.3%
Astigmatism				
≥1.00D difference between two principal meridians	26.4%	36.9%	20.8%	33.6%

Source: *Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error Study* [47]

(*AOA Clinical Practice Guidelines web page*)

- **Amblyopia**

Amblyopia is the leading cause of monocular vision loss in children. It is generally attributable to strabismus, anisometropia, combined strabismus and anisometropia, or form deprivation (e.g., media

opacity). Unilateral amblyopia is commonly associated with constant unilateral strabismus and/or amblyogenic anisometropia, while bilateral amblyopia usually results from high bilateral refractive error [5] or bilateral form deprivation.

Although amblyopia is a treatable condition in both children and adults, research demonstrates that the duration of treatment may be shorter and the end result better when diagnosed and treated early.[48-53] Estimates of the prevalence of amblyopia in young children are shown in Table 3.

(AOA Clinical Practice Guidelines web page)

- **Strabismus**

The estimated prevalence of strabismus in the general population varies from 2.5 percent to 4.6 percent based on various population studies.[54] The prevalence of strabismus in young children is shown in Table 3.

Although strabismus can develop at any age, it usually develops during childhood. Young children with constant unilateral strabismus often develop amblyopia and impaired stereopsis. Early identification and treatment of children with strabismus may prevent amblyopia.

Table 3: Prevalence of Amblyopia and Strabismus in Children 6 Months to 72 Months (6 Years) of Age

Condition	Non-Hispanic White	Hispanic	African American	Asian
Amblyopia	1.81%	2.6%	0.8% - 1.5%	1.81%
Strabismus	3.24% - 3.3%	2.4%	2.1% - 2.5%	3.55%

Source: *Multi-Ethnic Pediatric Eye Disease Study*[55,56] and the *Baltimore Pediatric Eye Disease Study* [57]

(AOA Clinical Practice Guidelines web page)

- **Non-strabismic binocular vision problems and accommodative disorders**

Binocular vision problems and accommodative dysfunctions comprise a group of neuromuscular disorders that may occur at any time after the normal development of binocular vision. A large-scale prospective study of the prevalence of vision disorders and ocular disease in a clinical population of children between the ages of 6 months and 18 years found that, after refractive conditions, the most common vision conditions in children are binocular and accommodative disorders.[58]

Convergence insufficiency (CI) is a binocular vision disorder that affects 2.25 percent to 5 percent of school-age children and is associated with symptoms such as visual fatigue, headaches and double vision when reading.[59-61] The Convergence Insufficiency and Reading Study Group investigators found that 13 percent of fifth and sixth grade children had clinically significant CI (insufficient fusional convergence, receded nearpoint of convergence, exophoria at near ≥4 prism diopters than far).[62]

Accommodative dysfunctions in children can make it hard to focus clearly on near objects, maintain focus for long periods, or easily change focus from near to far and back again. The studies that have been conducted to determine the prevalence of accommodative dysfunction, particularly in children, involve clinic populations. A study of over 2,000 children found that 1 percent between the ages of 6 months and 5 years 11 months, and 6 percent between the ages of 6 and 18 years had

accommodative disorders.[58] An investigation of the prevalence of symptomatic accommodative dysfunction in non-presbyopic patients (children and adults) found that 9.2 percent of these patients had accommodative insufficiency, 5.1 percent had accommodative infacility, and 2.5 percent had accommodative spasm.[63]

(AOA Clinical Practice Guidelines web page)

- **Color vision deficiency**

Children with color vision deficiency, either inherited or acquired, may have difficulty precisely matching colors or discriminating fine color differences. Inherited color vision deficiency is estimated to occur in nearly 8 percent of white males and less than 0.4 percent of white females, with lower prevalence in other ethnicities.[64] (Table 4) The severity of color vision deficiency can range from mild to severe. The most common form of color vision deficiency is red-green. Less common is blue-yellow color vision deficiency. Children can be reliably evaluated for color vision deficiency after 60 months (5 years) of age.[65]

Table 4: Prevalence of Inherited Color Vision Deficiency in Children 61 Months (5 years) to 72 Months (6 Years) of Age

Color Vision Deficiency	Non-Hispanic White	Hispanic	African American	Asian
Boys	7.8%	2.9%	2.1%	3.5%
Girls	<0.4%	<0.4%	<0.4%	<0.4%

Source: *Multi-Ethnic Pediatric Eye Disease Study* [64]

- **Ocular inflammatory disease**

Ocular inflammation in children includes an array of conditions, including but not limited to conjunctivitis, keratitis, scleritis, and uveitis. It may occur due to infection, trauma, malignancy, or autoimmune response. Inflammations can range from benign and self-limited to chronic and sight-threatening.[66, 67]

Systemic autoimmune diseases in children can have ocular manifestations that are vision-threatening. Juvenile Idiopathic Arthritis is associated with the development of chronic anterior uveitis. Other diseases with ocular inflammatory manifestations include sarcoidosis, Behçet's Disease and Sjögren's Syndrome.[67]

- **Retinopathy of prematurity**

Children born prematurely are at risk for the development of severe visual impairment and blindness. Preterm infants have higher rates of amblyopia, strabismus, optic atrophy, and refractive errors.[68-70]

The most common ocular problem in preterm infants is retinopathy of prematurity (ROP), a leading cause of potentially avoidable blindness. ROP is common in children with birth weight of less than 1,251 grams (g) and a gestational age of less than 28 weeks. Oxygenation of infants in the hours and days after birth may also be a contributing factor.[71] The frequency and severity of ROP is inversely related to gestational age and birth weight of the baby.[72] The Cryotherapy for Retinopathy of Prematurity trial reported the incidence of ROP was 47 percent in infants with birth weights between 1,000 and 1,251 g and 81.6 percent in infants weighing <1,000 g at birth. Sixty percent of infants born at 28 to 31 weeks developed ROP and over 80 percent of infants born before 28 weeks developed

ROP.[73]

- **Cataract**

Childhood cataracts can be classified as congenital or developmental. They may be inherited or due to infection (e.g., rubella), genetics (e.g., Down Syndrome) or eye injury. Congenital cataracts affect infants and young children. Prevalence of visually significant congenital cataracts is estimated to be three to four infants per 10,000 live births.[74]

- **Glaucoma**

Childhood glaucoma is an uncommon disease characterized by increased intraocular pressure leading to optic neuropathy and visual field changes, and is often associated with significant vision loss.[75] It may be inherited or associated with other eye disorders.

Glaucoma in children may be classified as congenital (present at birth), infantile (occurring between 1 to 2 years of age), or juvenile (developing after age 3). Most cases develop during the first year of life. A review of records of pediatric patients seen in one county in the United States over a 40 year period found an incidence of glaucoma of 2.29 per 100,000 persons younger than 20 years of age.[75]

- **Retinitis pigmentosa**

Retinitis pigmentosa (RP) is a group of hereditary retinal diseases characterized by progressive loss of peripheral vision and the development of night blindness. RP is caused by the degeneration of photoreceptor cells resulting in severe damage to the retina. While RP is usually limited to the eye, it may also occur as part of a syndrome (e.g., Usher syndrome, Bardet-Biedl syndrome).[76]

Retinitis pigmentosa is the most frequent cause of inherited visual impairment.[76] It is estimated to affect 1 in 3,000 to 1 in 4,000 people in the United States.[77]

- **Retinoblastoma**

Retinoblastoma, a cancer of the retina, usually affects children under age 5. The most common signs of retinoblastoma are leukocoria (white pupillary reflex) and strabismus. Retinoblastoma accounts for approximately 11 percent of cancers occurring in the first year of life, with 95 percent diagnosed before 5 years of age.[78] It is the most common intraocular cancer of childhood and affects approximately 300 children in the United States each year. More than 90 percent of children with retinoblastoma can be cured with early diagnosis and treatment;[79] however, significant disparities exist in the care and outcomes of children with retinoblastoma. A low socioeconomic status negatively affects the extent of the disease and ocular outcomes, presumably due to limited access to care. Hispanic children in particular have more advanced disease and higher rates of enucleation.[80]

- **Diabetic retinopathy**

Diabetes is the third most common chronic disease among children and a leading cause of blindness among young adults. Type 1 diabetes mellitus, the most common type in children until about 15 years ago, affects approximately 2 per 1,000 school-age children in the United States. Type 2 diabetes mellitus now accounts for about 45 percent of new cases of the disease.[81, 82]

Diabetic retinal disease, primarily manifesting as diabetic retinopathy (DR) and/or diabetic macular edema, is the most common microvascular complication of diabetes. Among pediatric patients, the average duration of diabetes before the development of DR is 5.7 to 9.1 years; however, the risk for developing DR is greater in patients who are diagnosed with diabetes during or after puberty.[81]

(AOA Clinical Practice Guidelines web page)

C. Access to Care

Although comprehensive pediatric eye and vision examinations are essential for timely diagnosis and treatment of eye disease and maintenance of good vision, many children do not receive comprehensive eye care. The Centers for Disease Control and Prevention report that fewer than 15 percent of preschoolers receive an eye examination by an eye care professional and fewer than 22 percent receive some type of vision screening.[83] In the Baltimore Pediatric Eye Disease Study of refractive error in preschool children in an urban population, 5.1 percent of the children tested could have benefited from having a spectacle lens prescription provided; however, only 1.3 percent had previously been prescribed eyeglasses.[46]

Factors that may limit access to comprehensive eye and vision examinations and treatment services include reliance on the false negative results of a school vision screening, the absence of signs, symptoms, or a family history of eye and vision problems,[84] or the inability of parents/caregivers to afford needed services due to lack of insurance coverage or limited family income.[85] This latter factor limiting access may now be partially resolved since pediatric eye and vision examinations by a doctor of optometry or other eye doctor (ophthalmologist) are an essential annual health care benefit for children from birth through age 19 through provisions of the *Patient Protection and Affordable Care Act* (ACA 2010). This allows more children to benefit from receiving an eye and vision examination.

Parents/caregivers need to receive accurate information about eye and vision problems, including the need for all children to have comprehensive eye care by a doctor of optometry or other eye doctor (ophthalmologist) regardless of vision screening outcomes.

D. Cost of Eye and Vision Disorders in Children

Eye and vision disorders can impose a significant burden on patients, parents and the public. The total economic cost of vision loss and eye disorders among children younger than 18 years of age in 2012 was estimated to be $5.9 billion.[86] This includes the direct medical costs for eye examinations, eyeglasses and low vision aids. Also, the debilitating nature of vision loss results in major indirect and nonmedical costs including special education services, federal assistance programs, and decreased quality of life.

The above estimate does not include the costs of educational services for children with undiagnosed and untreated vision conditions. Learning-related vision problems have been reported to be significant contributors to reading difficulties and ultimately to the need for special education services.[13, 14, 59, 87, 88] Vision problems can increase educational costs in the form of Individualized Education Programs (IEPs) and special education services, which would otherwise not be necessary, if the vision problems were treated. A study of children (ages 6-16) with IEPs found that they have high rates of undiagnosed and untreated vision problems affecting reading speed and comprehension.[89]

In addition to the current costs of care, future costs for undiagnosed and untreated vision problems may include the loss of a child's full potential, limitations on his or her occupational choices and future earnings, and the cost of more expensive care to treat visual impairment**.**

E. Early Detection and Prevention of Eye and Vision Disorders

Early detection and treatment are essential to preventing or reducing the development of vision conditions that have the potential to cause vision loss or affect visual development; however, many eye and vision problems do not have specific signs or symptoms that will alert a parent or caregiver to

the need for an eye and vision examination for their child. In some cases, a vision deficit may be perceived to be a problem with general development rather than a vision problem.[90]

Vision assessments or screenings can take many forms and occur in a variety of settings; however, vision screening alone will not lead to earlier diagnosis and treatment of amblyopia and other vision problems. Vision screenings are often limited in scope and lack the ability to detect the presence of many eye or vision problems, because the sensitivity of individual screening tests can vary widely.[90,91] Screening can identify who may be at risk for a vision problem, but a comprehensive eye and vision examination is required to diagnose it and determine treatment.[92]

Screening by a pediatrician or other primary care physician is important at birth and during the first 6 months of life when the visual system is highly susceptible to interference; however, low screening rates and inadequate referral and follow through with a comprehensive eye examination indicate that screening children in a pediatric or other primary care setting is not an optimal method for ensuring normal visual function.[93] (Evidence Grade: C)

Screening for vision problems in preschool children can be problematic and may lead to the under-detection of strabismus, amblyopia, and significant refractive error.[94] (Evidence Grade: A),[95] (Evidence Grade: A), [96] (Evidence Grade: B). Some preschoolers are unable to perform screening tests. Those unable to perform a screening have been found to be at higher risk of having amblyopia, strabismus, significant refractive error, or unexplained low visual acuity than children who passed a screening test. Children who are unable to perform a screening test are often not referred for a comprehensive eye and vision examination, but instead are managed as a child who passed the screening.[97] (Evidence Grade: B) The US Preventive Services Task Force has concluded that the current evidence is insufficient to assess the balance of benefits and harms of vision screening for children 3 years of age and younger.[98, 99] (Evidence Grade: B)

Vision screening by autorefraction only provides an estimate of refractive error; it is not a substitute for a comprehensive eye and vision examination.[100] Although autorefractors and symbol acuity cards can be used to screen preschoolers, the sensitivity of such tests is limited and does not compare favorably with a comprehensive eye and vision examination.[96] (Evidence Grade: B)

EVIDENCE-BASED ACTION STATEMENT: Vision screenings have not been found to be an optimal means of identifying which children need eye and vision care and which do not. A comprehensive eye and vision examination can determine if a child does or does not have an eye or vision problem requiring treatment. Therefore, vision screenings should not be considered as a substitute for an in-person comprehensive eye and vision examination.[93-99]

Evidence Quality: Grade B. Systematic reviews, Diagnostic studies, Reviews
Level of Confidence: Medium
Clinical Recommendation Level: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

Evidence Statements: Low screening rates and inadequate referral and follow through with a comprehensive eye examination indicate that screening children in a pediatric or other primary care setting does not result in optimal detection and treatment of vision problems.[93] (Evidence Grade: C)

Screening for vision problems in preschool children can be problematic and may lead to the under detection of strabismus, amblyopia, and significant refractive error.[94] (Evidence Grade: A), [95] (Evidence Grade: A), [96] (Evidence Grade: B).

Preschool children, who are unable to perform a screening test, are often not referred for a comprehensive eye and vision examination, but instead are managed as a child who passed the screening.[97] (Evidence Grade: B)

The US Preventive Services Task Force has concluded that the current evidence is insufficient to assess the balance of benefits and harms of vision screening for children 3 years of age and younger.[98, 99] (Evidence Grade: B)	
Potential Benefits: Greater efficacy in detection and treatment of eye and vision problems in children.	**Potential Risks/Harms**: None
Benefit and Harm Assessment: Benefits significantly outweigh harms.	
Potential Costs: Direct cost of testing.	
Value Judgments: The use of vision screening cannot provide the same level of diagnosis as a comprehensive eye and vision examination.	
Role of Patient Preferences: Small	
Intentional Vagueness: None	
Gaps in Evidence: Research is needed to compare the outcomes of vision screenings versus comprehensive eye and vision examinations.	

III. CARE PROCESS

A. Comprehensive Pediatric Eye and Vision Examination

The comprehensive pediatric eye and vision examination provides the means to evaluate the structure, function, and health of the eyes and visual system. It is preferable in most cases for the parent/caregiver to accompany the child into the examination room. The in-person interaction between patient/parent/caregiver and doctor is a dynamic process. It involves collecting subjective data directly from the patient and obtaining objective data by observation, examination, and testing. During the examination, information is obtained to explain symptoms reported by the patient and/or parent/caregiver and diagnose the cause of signs noted by a doctor of optometry or other eye doctor (ophthalmologist). It also provides the means to identify the presence of other ocular or systemic conditions that may exist without symptoms. (See Appendix Figure 1)

The goals of the comprehensive pediatric eye and vision examination are to:

- Evaluate the functional status of the eyes and visual system, taking into account special vision demands and needs
- Assess ocular health and related systemic health conditions
- Establish a diagnosis (or diagnoses)
- Formulate a treatment and management plan
- Counsel and educate the patient and/or parent/caregiver regarding visual, ocular and related systemic health care status, including recommendations for prevention, treatment, management, or future care.

1. General Considerations

Since the capabilities and needs of children vary significantly by age, the potential components of the comprehensive pediatric eye and vision examination have been divided into three age groups. This subdivision of the pediatric population is based on the developmental changes that occur from birth through childhood. Because a child can vary significantly from expected age norms, it is important not to rely solely upon chronological age when choosing testing procedures. Appropriate test procedures need to be based on the child's developmental age and specific capability.

a. Infants and Toddlers (newborn through 2 years of age)

Children in this age group generally perform best if the examination is early in the morning or after an infant's nap. Age-appropriate examination strategies should be used. It may be necessary to rely on objective examination procedures, and perform tests more rapidly than with older children.

b. Preschool Children (3 years through 5 years of age)

At about 3 years of age, children have achieved adequate receptive and expressive language skills to begin to cooperate for some of the traditional eye and vision tests; however, modifications are often needed in the testing to gather useful information. Beginning the examination with procedures that appear less threatening may help to put the child at ease. The use of subjective tests requiring verbal interaction should be limited.

c. School-age Children (6 to 11 and 12 to 18 years of age)

Although most of the examination procedures used with this age group are identical to those recommended for adults, age-appropriate modifications of instructions and testing targets may be needed for some younger children.

d. Examination Procedures**

The examination procedures described are not intended to be all-inclusive. Professional judgment and individual patient symptoms and findings may significantly influence the nature and course of the examination. It is important to remain alert for new and emerging technologies, instruments, and procedures and incorporate them into the clinical examination, as appropriate.

CONSENSUS-BASED ACTION STATEMENT: A comprehensive pediatric eye and vision examination should include, but is not limited to:

- Review of the nature and history of the presenting problem, patient and family eye and medical histories, including visual, ocular, general health, and developmental and school performance history of the child.
- Measurement of visual acuity
- Determination of refractive status
- Assessment of binocular vision, ocular motility, and accommodation
- Evaluation of color vision (baseline or periodic, if needed, for qualification purposes or if disease related)
- Assessment of ocular and systemic health, including evaluation of pupillary responses, anterior and posterior segment, peripheral retina, measurement of intraocular pressure and visual field testing.

Refer to III. Care Process, A. section 9 for a listing of potential benefits and harms of testing.

Evidence Quality: There is a lack of published research to support or refute the use of all of the tests and/or assessments included in this recommendation.

Benefit and Harm Assessment: Implementation of this recommendation is likely to result in the enhanced ability to diagnose any eye or vision problems in infants and children. The benefits of this recommendation were established by expert consensus opinion.

** See Appendix Tables 1, 2, and 3 for a listing of specific tests by age group.

2. Patient History

The patient history is an initial and ongoing component of the examination. The objective is to obtain specific information about the patient and/or parent's/caregiver's perception of the child's eye and vision status and important background information on related medical issues. It helps to identify and assess problems, and it provides an opportunity to become acquainted with the patient and/or his/her parents or caregivers, establishing a relationship of confidence and trust.

The collection of demographic data generally precedes the taking of the patient history. Having the parent or caregiver fill out a questionnaire may facilitate obtaining the patient history. Major components of the patient history include, but are not limited to:

- Nature and history of the presenting problem, including chief complaint
- Visual and ocular history
- General health history, including prenatal, perinatal and postnatal history, and review of systems
- Medication reconciliation, including prescription and nonprescription drugs (e.g., over the counter medications, supplements, herbal remedies) and documentation of medication allergies
- Family ocular and medical history

  Clinical note: Because it is a possible risk factor for the progression of myopia in school-age children, it is recommended that the patient history should also review the refractive status of both parents.[101, 102] *(Evidence Grade: B)*
- Developmental history of the child
- School performance history of school-age children
- Names of, and contact information for, the patient's other health care providers.

3. Testing of Infants and Toddlers (newborn through 2 years of age)

a. Visual Acuity

Estimation of visual acuity in an infant or toddler can help to confirm or reject certain hypotheses about the level of visual system development, including binocularity, and provide direction for the remainder of the eye and vision examination. Assessment of visual acuity for infants and toddlers may include these procedures:

- Fixation preference test

Visual acuity can be estimated based on the strength of the fixation preference. In the absence of strabismus, fixation preference testing with a vertical base up or base down 10 prism diopter lens

to create diplopia can be used to detect a two-line or more visual acuity difference between the eyes.[103] Fixation preference testing results need to be interpreted in the context of all other available information (e.g., degree and type of anisometropia, frequency and type of strabismus).

Clinical note: Results of fixation preference testing may be unreliable for diagnosing amblyopia,[104, 105] (Evidence Grade: C) particularly secondary to anisometropia; therefore, monocular visual acuity measurements should be obtained as soon as possible.[106] (Evidence Grade: B)

- Preferential looking visual acuity

Preferential looking methods are useful for the assessment of visual acuity in infants and toddlers. Grating acuity targets (e.g., Teller acuity cards) and vanishing optotypes (e.g., Cardiff acuity test) can provide estimates of resolution visual acuity.[107]

- Visual evoked potential

Electrodiagnostic testing, such as visual evoked potentials, is an objective method that can be used to provide an estimate of visual acuity in infants.[108]

b. Refraction

Objective measures of refraction may need to be relied on in this age group because of the short attention span and poor fixation of infants. The refractive error measurement should be analyzed with other testing data obtained during the examination. This information is used to determine if, and in what amount, an optical correction is needed. Procedures may include:

- Cycloplegic retinoscopy

When performing cycloplegic retinoscopy in an infant or toddler, the cycloplegic agent should be selected carefully (dosage should be based on the child's weight, iris color, and dilation history) to avoid over dosage.[109] The lowest concentration of drug that yields the desired cycloplegia should be used. A concentration of 0.5% cyclopentolate hydrochloride can be used in most infants under 12 months of age and a 1% concentration for older children.[110] The potential for systemic absorption may be reduced with nasolacrimal occlusion.

Clinical note: Spray administration of cyclopentolate to the closed eyes of young children is an acceptable alternative to using eye drops and is often better tolerated and less distressing than other methods of drug administration;[111-114] (Evidence Grade: B) however, the use of cyclopentolate spray in children with dark irides may not achieve adequate cycloplegia.[115] (Evidence Grade: C) Spray caps are available for use on bottles of cyclopentolate, eliminating the need to have the spray compounded by a pharmacy.

Clinical note: The cycloplegic of choice is cyclopentolate hydrochloride; however, when it is not available or is contraindicated, Tropicamide 1% has also been shown to be effective for the measurement of refractive error in non-strabismic infants.[116] (Evidence Grade: C)

- Static (near) retinoscopy

Static retinoscopy performed at near is an objective measure of estimating refractive error in infants and toddlers,[117] but should be used with caution as a substitute for cycloplegic retinoscopy.[118] It may be useful when a child/parent is extremely anxious about instillation of cycloplegic agents, or the child has had or is at risk for an adverse reaction to cycloplegic agents.[119]

c. Binocular Vision and Ocular Motility

Depending on the patient's age, level of cooperation, and visual signs and symptoms, appropriate tests of binocular vision and ocular motility can be incorporated into the examination. Testing in this age group may include:

- Cover test

The unilateral cover test at near can generally be used with very young children. If cover test results are unreliable because of the child's resistance to testing, use of the Hirschberg test may be successful. Prisms can be used with the Hirschberg test to align the corneal reflections (Krimsky test) and estimate the magnitude of any deviation.

- Brückner test

If cover test results are equivocal, particularly in young or uncooperative patients, the Brückner test may be helpful in detecting small angle strabismus. It may also be useful in the clinical evaluation of anisometropia in infants and young children.[120] Increasing the examination distance from one meter to four meters can improve its sensitivity for detecting anisometropia.[121]

- Stereopsis

Testing of stereopsis, after 6 months of age, can provide a sensitive measure of visual development in infants.[122]

Clinical note: Infants and toddlers may be evaluated for binocularity with random dot stereoacuity cards using a preferential looking technique.[122, 123] (Evidence Grade: C)

- Near point of convergence (NPC)

Assessment of convergence ability may be determined objectively in infants using a penlight or other target.

- Ocular motility assessment

Fixation and eye tracking abilities may be assessed using a penlight, small toy, or other object.

4. Testing of Preschool Children (3 through 5 years of age)

a. Visual Acuity

One of the primary goals of measuring visual acuity in young children is to detect amblyopia so that it can be treated successfully. Acuity tests for this age group ideally involve a matching or a forced-choice task, such as pointing to the correct response. An assessment of visual acuity may include the use of:

- Symbol optotype or letter matching visual acuity testing

Clinical note: Symbol optotype testing (e.g., Lea symbols) and letter matching testing (e.g., HOTV) can be used to estimate the visual acuity of most children aged 3 to 5 years[124-127] (Evidence Grade: B), preferably when presented as single letters or shapes with surround bars.[128] It is recommended; however, that letter optotypes be used for testing visual acuity as soon as practical in a child's development.[128,129] (Evidence Grade: C)

b. Refraction

A refraction may include objective and subjective assessment of the child's refractive status; however, the results of a refraction do not provide all the information needed to determine an optical prescription. The refractive error measurement should be analyzed with other testing data and an assessment of the patient's visual needs obtained during the in-person examination. This information is used to determine if, and in what amount, an optical correction is needed to provide optimal vision and comfort for all viewing distances. Testing in this age group may include:

- Static (distance) retinoscopy

Use of a lens rack or loose lenses rather than a phoropter enables the child's face to be seen and allows for observation if the child loses fixation.

- Cycloplegic retinoscopy

Cycloplegic retinoscopy is the preferred procedure for the first evaluation of preschoolers or when static retinoscopy yields unreliable results. It is also useful when strabismus or significant refractive error is present.

Clinical note: Spray administration of cyclopentolate to the closed eyes of young children is an acceptable alternative to using eye drops and is often better tolerated and less distressing than other methods of drug administration;[111-114] (Evidence Grade: B) however, the use of cyclopentolate spray in children with dark irides may not achieve adequate cyclopelgia.[115] (Evidence Grade: C) Spray caps are available for use on bottles of cyclopentolate, eliminating the need to have the spray compounded by a pharmacy.

- Autorefraction

The use of a hand-held autorefractor is preferable in this age group since it is less intimidating than a table mounted instrument.

Clinical note: Autorefractors can provide an objective measure of refractive error, but may overestimate the level of myopia under non-cycloplegic conditions,[130,131] (Evidence Grade: C) and their usefulness in testing children less than 3 years of age may be limited.[132] (Evidence Grade: B)

c. Binocular Vision, Ocular Motility, and Accommodation

- Cover test

Testing may include use of the unilateral cover test and alternating cover test. If cover test results are unreliable because of the child's resistance to testing, use of the Hirschberg test may be successful. Prisms can be used with the Hirschberg test to align the corneal reflections (Krimsky test) and estimate the magnitude of any deviation.

- Ocular motility assessment

Qualitative examination of eye movements generally involves an assessment of the stability of fixation, saccadic function, and pursuit function.

- Near point of convergence (NPC)

Assessment of maximum convergence ability may be determined objectively or subjectively.

- Stereopsis

In the absence of other clinical findings, such as amblyopia, anisometropia, or strabismus, the measurement of stereopsis in preschool children is a reliable indication of binocular function.[133] (Evidence Grade C)

Clinical note: Stereopsis testing can usually be performed in young children (4 to 7 years of age) to evaluate binocular vision;[134, 135] (Evidence Grade: B) however, they may demonstrate reduced stereoacuity on initial testing and can benefit from repeat testing.[136] (Evidence Grade: B)

Clinical note: Some tests of stereoacuity have shortcomings (e.g., Titmus and Randot [version 2] circles tests) in that they have monocular cues allowing individuals with strabismus and amblyopia to report correct answers.[137] (Evidence Grade: B)

- Positive and negative fusional vergences

Assessment of positive and negative fusional vergence ranges can be done using a step vergence procedure with a hand-held prism bar to help determine whether treatment is indicated.[138,139]

- Accommodative testing

Clinical note: Dynamic retinoscopy has been shown to be a reliable method for assessing accommodation in young children.[140,141] (Evidence Grade: B)

d. Color Vision

Children with color vision deficiency, either congenital or acquired, may have difficulty precisely matching colors or discriminating fine color differences.[142] The severity of color vision deficiency can range from mild to severe depending on the cause.

It is helpful to know whether a color vision deficiency exists, because severe color vision deficiency may cause mislabeling of a child as learning disabled.[143] Identification of abnormal color vision prior to school age is also important, since part of the early educational process generally involves the use of color identification and discrimination. The presence of a color vision deficiency may also indicate an ocular health problem; therefore, color vision testing may need to be repeated, if an acquired color vision deficiency is suspected.

Clinical note: Although effective when used with standard illuminant C, some pseudoisochromatic plate tests only detect protan and deutan color vision deficiency,[144] (Evidence Grade: C) while other color vision tests provide the added advantage of detection of tritan defects and the ability to categorize defects as mild, moderate, or severe.[145] (Evidence Grade: C)

5. Testing of School-Age Children (6 to 11 and 12 to 18 years of age)

a. Visual Acuity

Visual acuity may be measured monocularly and binocularly, at distance and near, with and without the child's most recent spectacle or contact lens correction. An assessment of visual acuity in children age 6 years or older may include:

- Snellen visual acuity

For some children less than 8 years old, Snellen visual acuity testing may need to be modified by isolating one line, or even one-half line of letters.

- Early Treatment of Diabetic Retinopathy Study (ETDRS) visual acuity chart

The ETDRS chart may be used to measure visual acuity in school-age children[146] and can be especially useful in diagnosing and monitoring children with amblyopia.

b. Refraction

A refraction may include objective and subjective assessment of the child's refractive status; however, the results of a refraction do not provide all the information needed to determine an optical prescription. The refractive error measurement should be analyzed with other testing data and an assessment of the patient's visual needs obtained during the examination. This information is used to determine if, and in what amount, an optical correction is needed to provide optimal vision and comfort for all viewing distances.

Both objective and subjective testing for refractive error can generally be used in this age group. It may include:

- Static (distance) retinoscopy

Retinoscopy may be performed with a phoropter, or without a phoropter using a lens rack or loose lenses and fogging glasses.

- Cycloplegic retinoscopy

A cycloplegic refraction may be necessary when conditions such as strabismus, amblyopia, or significant hyperopia are present.

Clinical note: In school-age children, cycloplegic refraction results in a more positive spherical power measurement than obtained using optical fogging techniques to relax accommodation.[147] (Evidence Grade: B) The difference in spherical equivalent refractive errors measured in pre- and post-cycloplegic refractions is significant up until age 20.[148] (Evidence Grade: B)

- Subjective refraction

Typical examination procedures used to measure refractive error in adults can generally be used for school-age children.

- Autorefraction

Autorefraction may be used as a starting point, but not as a substitute for subjective refraction. Retinoscopy; however, when performed by an experienced clinician, is more accurate than automated refraction for determining a starting point for non-cycloplegic refraction.[149] (Evidence Grade: C)

c. Binocular Vision, Ocular Motility, and Accommodation

In analyzing the results of these tests, it is important to examine all the data and group findings rather than depend on a single finding to arrive at a diagnosis. Testing in this age group is similar to that for adults and may include:

- Cover test

Testing may use the unilateral cover test and alternating cover test. If cover test results are unreliable because of the child's resistance to testing, use of the Hirschberg test may be successful. Prisms can be used with the Hirschberg test to align the corneal reflections (Krimsky test) and estimate the magnitude of any deviation.

- Ocular motility assessment

Qualitative examination of eye movements generally involves an assessment of the stability of fixation, saccadic function and pursuit function. Versions may also be performed to rule out a noncomitant deviation.

- Near point of convergence (NPC)

Determination of maximum convergence ability may be obtained objectively or subjectively.

- Stereopsis

School-age children should be able to complete any of the available random dot stereopsis tests.

- Positive and negative fusional vergences

Testing can assess both the amplitude and facility of fusional vergence responses.

- Accommodative testing

Assessment of accommodation may include accommodative amplitude, facility and response.[150] Testing of negative relative accommodation (NRA) and positive relative accommodation (PRA) may provide useful information on both accommodative and binocular status.

*Clinical note**:** To assess retinal blur during near work, accommodative lag can be evaluated with the child's habitual and manifest corrections.[151] (Evidence Grade: B)*

d. Color Vision

If not done previously, school-age children should be tested for color vision deficiency. Color vision deficiency can interfere with daily activities involving colors and prohibit some occupational choices.[65] (Evidence Grade: D) One-third of individuals with abnormal color vision reported their career choice had been affected by color vision deficiency and one-quarter had been precluded from an occupation because of it or had problems in their current job.[152]

CONSENSUS-BASED ACTION STATEMENT: Abnormal color vision can affect daily performance of activities involving color discrimination and may interfere with or prevent some occupational choices later in life. Children should be tested as soon as practical after 60 months (5 years) of age for color vision deficiency and the parents/caregivers of children identified with color vision deficiency should be counseled.
Evidence Quality: There is a lack of published research to support or refute the use of this recommendation.
Benefit and Harm Assessment: Implementation of this recommendation is likely to increase early detection of color vision deficiency and alert parents/caregivers to any potential effects on a child's education or occupational choices. The benefits of this recommendation were established by expert consensus opinion.

6. Ocular and Systemic Health Assessment

Thorough assessment of the health of the eyes and associated structures is an important and integral component of the comprehensive pediatric eye and vision examination. The eyes and associated

structures are not only sites for primary ocular diseases, but they are also subject to systemic disease processes that affect the body as a whole (e.g., disorders of neurologic, vascular, endocrine, immune or neoplastic origin).

Standard procedures used in evaluating adult patients may need to be modified or may not be optimal in very young patients. With some modifications, the components of the ocular and systemic health assessment may include:

a. Assessment of Pupillary Responses

Evaluation of pupil size, shape, symmetry and direct and consensual responses to light.

b. Visual Field Evaluation (Confrontation)

Confrontation visual field testing can be used to detect gross peripheral defects and areas of constricted visual fields.

Clinical note: The diagnostic accuracy of confrontation visual field testing is low for mild to moderate visual field defects and when performed as a stand-alone test;[153] (Evidence Grade: B) however, it has high positive predictive value when a field loss is demonstrated.[154] (Evidence Grade: C) The sensitivity of confrontation testing can be improved by using two testing procedures (e.g., kinetic testing with a 5mm red target along with static finger wiggle testing).[153] (Evidence Grade: B)

c. Evaluation of the Ocular Anterior Segment and Adnexa

Assessment of the external eye and adnexa, tear film, ocular surfaces, anterior chamber, and crystalline lens.

d. Evaluation of the Ocular Posterior Segment

Pharmacological dilation of the pupil is generally required for thorough stereoscopic evaluation of the ocular media, retinal vasculature, macula, optic nerve and the peripheral retina.[155] (Evidence Grade: B)

Clinical note: Examination under general anesthesia may be considered if the retina cannot be adequately visualized during an examination of at-risk children or those with high myopia (>6.00D).[156] (Evidence Grade: C) It also may be needed for other children who are unable or unwilling to participate in testing.

e. Measurement of Intraocular Pressure

Measuring intraocular pressure (IOP) is a part of the comprehensive pediatric eye and vision examination. Although the prevalence of glaucoma is low in children, measurement of IOP should be attempted. Pressure should be assessed when ocular signs and symptoms or risk factors for glaucoma exist. If risk factors are present and reliable assessment of IOP under standard clinical conditions is impossible, testing under sedation may be indicated. Recording of tonometry results should include method used and time of day.[157] (Evidence Grade: C)

Clinical note: The Goldmann applanation tonometer is considered the reference standard for the measurement of IOP; however, its use may not be practical in very young children. Non-contact and handheld applanation tonometers can provide IOP measurements close to that of the Goldmann.[158] (Evidence Grade: A)

7. Supplemental Testing

During an eye and vision examination, the doctor of optometry or other eye doctor (ophthalmologist) continually assess the information obtained from the patient along with the clinical findings gathered. The interpretation of subjective and objective data may indicate the need for additional testing.

Additional testing may be indicated to:

- Confirm or rule out differential diagnoses
- Enable more in-depth assessment
- Provide alternative means of evaluating patients who may not be fully cooperative or who may not comprehend testing procedures.

Supplemental procedures may be performed immediately or during subsequent examinations. If supplemental testing is performed, an interpretation and report may be required. Supplemental testing for infants and children may include:

a. Electrodiagnostic Testing

Electrophysiological techniques may be used to assess young children with unexplained reduced vision due to retinal or neural disease and for the testing and diagnosis of inherited vision disorders. Testing may include an electroretinogram (ERG) or measurement of visual evoked potential (VEP).

b. Ocular Imaging

The following procedures may be used for imaging of ocular structures:

- Ultrasonography can reveal congenital anatomical abnormalities in the eye and orbit, as well as anatomical changes secondary to disease or injury, and measure axial length
- Optical coherence tomography (OCT) provides cross-sectional, high-resolution imaging of the microscopic structure of the retina and optic nerve
- Scanning laser ophthalmoscopy provides 3-D images of the optic nerve head
- Fundus photography, with or without auto fluorescence, is a noninvasive diagnostic technique for examining the fundus.

c. Testing for Learning-related or Visual Information Processing Problems

Some vision problems can interfere with learning. When a child's history or initial testing indicates a possible developmental lag or a learning problem, visual information processing test(s) may be administered to help diagnose any vision-related problems. The testing can help assess the level of visual development, detect visual perceptual dysfunction, and enable early identification of children at risk for the development of learning-related vision problems.

An Individualized Education Program (IEP) is required under the *Individuals with Disabilities Education Act* (IDEA) for children with:

- An obvious physical anomaly (e.g., strabismus, ptosis, nystagmus) or family history of amblyopia, strabismus or other early eye disease
- Central nervous system dysfunction (e.g., Cerebral Palsy, Down Syndrome, Developmental

Delay)

- Autism Spectrum Disorder
- Enrolled in Early Intervention programs (e.g., early Head Start)
- Born from high-risk pregnancy (e.g., maternal drug use, infection during pregnancy, preterm delivery).

These children are considered at high risk and require direct referral ~~to an eye doctor~~ for a comprehensive pediatric eye and vision examination.

CONSENSUS-BASED ACTION STATEMENT: Children at risk for learning-related vision problems should be evaluated by a doctor of optometry or other eye doctor (ophthalmologist)
Evidence Quality: There is a lack of published research to support or refute the use of this recommendation.
Benefit and Harm Assessment: Implementation of this recommendation is likely to result in more in-depth evaluation and diagnosis of children with learning-related vision problems. The benefits of this recommendation were established by expert consensus opinion.

(AOA Clinical Practice Guidelines Web page)

d. Examination of Children with Special Needs

Many children with special needs have undetected and untreated visual problems[159] (see Appendix Table 4: Partial Listing of Ocular Manifestations of Neurodevelopmental Disorders and Other Syndromes). Children with developmental or intellectual disabilities have a higher rate of vision disorders and should receive a comprehensive pediatric eye and vision examination.[19, 23, 160] Although clinically more challenging, visual assessment is possible in the majority of these children.[159] (Evidence Grade: B) [161] (Evidence Grade: B) Early identification of specific visual deficits could lead to interventions to improve the educational and occupational achievement and quality of life for these high-risk children.

CONSENSUS-BASED ACTION STATEMENT: Many children with developmental or intellectual disabilities have undetected and untreated vision problems and should receive a comprehensive pediatric eye and vision examination.
Evidence Quality: There is a lack of published research to support or refute the use of this recommendation.
Benefit and Harm Assessment: Implementation of this recommendation is likely to result in improved quality of life and educational and occupational achievement for these high-risk children. The benefits of this recommendation were established by expert consensus opinion.

e. Evaluation for Ocular Manifestations of Child Abuse

External eye trauma (e.g., conjunctival hemorrhages, lid lacerations, corneal scars or opacities) and retinal trauma (hemorrhages, folds, tears, and detachments) are common ocular findings from child abuse and can have an important role in its diagnosis.[162-165] Most often the child is between 2 and 18 months of age at the time of abuse.[164, 166]

The eyes can be direct or indirect targets of child abuse and may provide valuable diagnostic information, particularly when there are limited external signs of abuse. The presence of retinal hemorrhages, which are typically present in both eyes, are an important diagnostic sign in about 75 percent of cases of abusive head trauma.[167] Retinal hemorrhages, poor visual response, and poor pupil response in an infant may indicate abusive head trauma, or Shaken Baby Syndrome,[162] (Evidence Grade: B),[163] (Evidence Grade: C) a form of child abuse in which the child is injured secondary to violent shaking.

A vague history that changes on re-questioning or is inconsistent with the age of the child or extent of the injury should be an alert for abuse. In such cases, a detailed history is one of the most important factors to consider when assessing whether a child has been abused.[165]

All 50 states and the District of Columbia have laws mandating the reporting of suspected child abuse and provide penalties for failure to do so.

U.S. Department of Health and Human Services, Administration for Children & Families, Children's Bureau listing of state child abuse and neglect reporting numbers.

CONSENSUS-BASED ACTION STATEMENT: Doctors of optometry and other eye doctors (ophthalmologists) should be aware of the eye-related findings associated with abusive head trauma and report findings of possible child abuse to the proper authorities, as defined by state law, for the protection of the child.

Evidence Quality: There is a lack of published research to support or refute the use of this recommendation.

Benefit and Harm Assessment: Implementation of this recommendation is likely to help alert child welfare officials of possible child abuse or neglect and prevent additional abuse. The benefits of this recommendation were established by expert consensus opinion.

8. Assessment and Diagnosis

At the completion of the examination, the data collected should be assessed and evaluated to establish a diagnosis (or diagnoses) and formulates a treatment and management plan. The nature and severity of the problem(s) diagnosed determine the need for optical prescription (e.g., eyeglasses or contact lenses) or other treatment (e.g. vision rehabilitation, vision therapy, ocular pharmaceuticals).

A prescription for correction of any refractive error, if needed, is provided at the conclusion of the examination.[168] The level of refractive error in infants and toddlers may be monitored rather than prescribed as a lens correction. In older children, full or partial optical correction may be prescribed depending on the specific visual needs, refractive measurement, and related visual findings.

For some patients, referral for consultation with or treatment by another doctor of optometry or other eye doctor (ophthalmologist), the patient's primary care physician, or another health care provider may be indicated.

9. Potential Benefits and Harms of Testing

The potential benefits of a comprehensive pediatric eye and vision examination may include:

- Optimizing visual function through diagnosis, treatment and management of refractive, ocular motor, accommodative and binocular vision problems

- Preventing and/or minimizing vision loss through early diagnosis, treatment and management of ocular health conditions

- Detecting systemic disease and referral for appropriate care

- Counseling and educating patients/parents/caregivers on current conditions and preventive care to maintain ocular and systemic health and visual function, and on the relationship between vision problems and early learning.

Potential harms associated with a comprehensive pediatric eye and vision examination may include:

- Patient or parent/caregiver anxiety about testing procedures or resulting diagnosis

- Adverse ocular and/or systemic reactions

- Temporary visual disturbances resulting from testing, or allergic responses to diagnostic pharmaceutical agents or materials used

- Missed or misdiagnosis of eye health or vision problems

- Unnecessary referral or treatment.

B. Management

1. Counseling and Education

It is important for children/parents/caregivers to understand the medical information and recommendations given to them. To enhance understanding, open-ended questions should be used and children/parents/caregivers asked to restate their understanding of the information given them using their own words.[169] Eye models, diagrams and written materials can also be used to aid in increasing understanding.

Shared decision-making increases patient/parent/caregiver satisfaction with the examination and consultation, and may improve health outcomes. The available options, with their benefits and risks, need to be described and patient/parent/caregiver views and preferences elicited, before agreeing on a course of action.[170]

Language and cultural differences or misunderstandings may prevent some individuals from accepting a doctor's recommendation. When communicating with patients/parents/caregivers, it is important to take their level of "health literacy" into consideration.[171] Health literacy is "the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate decisions regarding their health."[172] Limited health literacy has been associated with a range of adverse health outcomes including decreased use of preventive services and poor disease specific outcomes.[173]

In addition, anxiety reduces the effectiveness of patient-practitioner communications and results in reduced attention, recall of information, and compliance with treatment. The use of "patient-centered" communications and "active listening" can help reduce anxiety and improve patient/parent/caregiver satisfaction and outcomes.[174] Improved doctor-patient communications and higher levels of patient/parent/caregiver involvement in care are linked to better clinical outcomes.[175]

In compliance with the *Americans with Disabilities Act* (ADA), reasonable accommodations need to be made to ensure that whatever is written or spoken is clear and understandable to individuals with disabilities. Appropriate auxiliary aids and services must be made available, when needed, to enable effective communications when evaluating, treating, or counseling persons with hearing, vision, or speech impairments. According to the ADA, auxiliary aids and services for individuals who are hearing impaired include qualified interpreters, note takers, computer-aided transcription services, written materials, telephone handset amplifiers, assistive listening systems, telephones compatible with hearing aids, closed caption decoders, open and closed captioning, telecommunications devices for the deaf (TDD's), videotext displays and exchange of written notes. For individuals with vision impairments, auxiliary aids and services include qualified readers, taped texts, audio recordings, magnification software, optical readers, Braille materials, and large print materials. Examples for individuals with speech impairments include TDD's, computer terminals, speech synthesizers, and communication boards.[176]

CONSENSUS-BASED ACTION STATEMENT: At the conclusion of a comprehensive pediatric eye and vision examination, the diagnosis should be explained to the patient/parent/caregiver and related to the patient's symptoms, and a treatment plan and prognosis discussed.

Evidence Quality: There is a lack of published research to support or refute the use of this recommendation.

Benefit and Harm Assessment: Implementing this recommendation is likely to increase patient/parent/caregiver understanding of any diagnosed eye or vision problems and improve compliance with any recommended treatment. The benefits of this recommendation were established by expert consensus opinion.

Patient/parent/caregiver counseling and education may include:

- Review of the child's visual and ocular health status in relation to his/her visual symptoms and complaints
- Discussion of any refractive correction that provides improved visual efficiency and/or appropriate eye protection
- Information on the relationship between vision problems and reading/learning
- Explanation of available treatment options for diagnosed eye or vision conditions, including risks, benefits, and expected outcomes
- Recommendation of a course of treatment with the reasons for its selection and the prognosis
- Discussion of the importance of patient compliance with the treatment prescribed
- Recommendation for follow-up care, re-examination, or referral.

When appropriate, patients/parents/caregivers should also be counseled about:

a. Eye Safety and Protection

Eye injury is a leading cause of monocular blindness in the United States and a common reason for eye-related emergency department visits. Eye injuries treated in U.S. hospital emergency rooms among children less than 18 years of age averaged over 70,000 annually in 1990 through 2009.[177] (see Table 5) The risk for eye injuries in children is highest in 15 to 17 year olds. The most common eye injuries are due to abrasions or foreign bodies.[178]

The majority of eye injuries in children occur in the home[177] and are predominately caused by sports and recreation activities, chemicals, or household products,[177,179] Most eye injuries are preventable with appropriate use of protective eyewear;[180, 181] however, in a National Health Interview Survey of children participating in activities that can cause eye injury, only 14.5 percent were reported to wear protective eyewear all or most of the time. Older children (12 to 17 years of age) were more likely to use protective eyewear than younger children.[182]

Table 5: Most Common Pediatric Eye Injuries Treated in U.S. Emergency Departments[177]

1.	Sports and recreation (e.g., basketball, baseball, football, playground equipment)
2.	Household chemicals (e.g., cleaning agents, bleach, pesticides)
3.	Housewares and furniture (e.g., microwaves, flatware, tables)
4.	Toys
5.	Desk supplies (e.g., pens, pencils, scissors)
6.	Tools and hardware (e.g., hammers, nails)
7.	BB and pellet guns
8.	Tobacco products (e.g., cigarettes, cigars, pipes)
9.	Fireworks

It is important to discuss eye safety issues with children/parents/caregivers, including eye hazards at school or home, and during sports and recreational activities and to promote the use of appropriate protective eyewear to help reduce the incidence of eye injuries among children.[177] (Evidence Grade: B) [183] (Evidence Grade: B) Prevention strategies should focus on the use of protective eyewear, parental supervision, and on childhood education about both the risks of eye injury and the utility of protective eyewear.[178] (Evidence Grade: B) [184]

EVIDENCE-BASED ACTION STATEMENT: Parents/caregivers and children should be educated about potential risks for eye injuries at home, at school, and during sports and recreational activities, and advised about safety precautions to decrease the risk of ocular injury.[177,183] Prevention of eye injuries in children should focus on the use of protective eyewear, parental supervision, and include education about both the risks of eye injury and the benefits of protective eyewear.[178]

Evidence Quality: Grade B: Retrospective cohort studies
Level of Confidence: Medium
Clinical Recommendation Level: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

Evidence Statements: It is important to discuss eye safety issues with children/parents/caregivers.[177] (Evidence Grade: B),[183] (Evidence Grade: B)

Prevention strategies should focus on the use of protective eyewear, parental supervision, and on childhood education about both the risks of eye injury and the utility of protective eyewear.[178] (Evidence Grade: B)

Potential Benefits: Reduction in eye injuries in children.	**Potential Risks/Harms**: None

Benefit and Harm Assessment: Benefits significantly outweigh harms.

Potential Costs: Direct cost of counseling as part of a pediatric eye and vision examination.
Value Judgments: None
Role of Patient Preferences: None
Intentional Vagueness: Specific type/form of counseling is not stated, as it is patient specific.
Gaps in Evidence: Research is needed to determine the risks and methods of eye protection associated with specific eye injuries in children in order to design appropriate prevention strategies.

b. Ultraviolet Radiation and Blue Light Protection

Children/parents/caregivers should be advised about the need to protect children's eyes from excessive exposure to sunlight. Sunlight is comprised of ultraviolet (UVA and UVB) radiation and short wavelength visible energy (blue light) which can cause acute effects and may also lead to chronic effects over the life of the individual. The eyes of infants and young children are known to have a higher level of UV and short wavelength transmittance than older children and adults, making them more susceptible to energy-related injury.[185, 186]

Exposure to high levels of UV–containing sunlight, especially when reflected from snow, can cause acute photokeratitis and keratoconjunctivitis. Chronic exposure to even low levels of UV radiation is a risk factor for developing cataracts, pterygium, squamous cell carcinoma of the cornea and conjunctiva, and skin cancer.[187] Epidemiological evidence also shows that excess chronic sunlight exposure leads to a significantly increased risk for developing age-related macular degeneration as an older adult.[188]

Exposure to high levels of short wavelength visible energy (blue light) also has the potential to cause photochemical retinal damage, which is known to occur with direct sun viewing.[189, 190] In addition, the increased evening use of laptops and other broad spectrum self-illuminated devices rich in blue light has been suggested to interfere with good sleep hygiene, especially in adolescents.[191]

Children can reduce the potential for eye damage from UV radiation and blue light by not looking directly at the sun, and wearing sunglasses and brimmed hats when outdoors.

CONSENSUS-BASED ACTION STATEMENT: All children and their parents/caregivers should be advised about the benefits of the regular use of sunglasses that effectively block at least 99 percent of UVA and UVB radiation, the use of hats with brims when outdoors, and the importance of not looking directly at the sun.
Evidence quality: There is a lack of published research to support or refute the use of this recommendation.
Benefit and Harm Assessment: Implementing this recommendation is likely to decrease patient risk of eye health problems from acute or chronic exposure to UV radiation and blue light. The benefits of this recommendation were established by expert consensus opinion.

c. Impact of Near Work and Reduced Time Outdoors on Vision

The prevalence of myopia in children has been increasing significantly in the past few decades.[38] Environmental factors such as time spent on reading and other near activities and the limited amount of time spent outdoors have been cited as potential factors contributing to the increase.[192] Most

children spend considerable time each day using computers, tablets or smart phones at school and at home. As a result, they may be spending less time outdoors.

Although there is conflicting evidence, more time spent outdoors and less time indoors doing near work may slow myopia progression and prevent high myopia.[192] (Evidence Grade: A), [193] (Evidence Grade: B), [194] (Evidence Grade: B),[195] (Evidence Grade: D)

EVIDENCE-BASED ACTION STATEMENT: Patients/parents/caregivers should be counseled about the benefits to children's vision of spending more time outdoors.[192-195]

Evidence Quality: Grade B. Randomized clinical trial, prospective cohort studies, cross-sectional study
Level of Confidence: Medium
Clinical Recommendation Level: Recommendation. This recommendation should generally be followed, but remain alert for new information.

Evidence Statements:
More time spent outdoors and less time indoors doing near work may slow axial elongation and prevent high myopia thereby reducing the risk of developing sight-threatening conditions such as retinal detachment and myopic retinopathy.[192] (Evidence Grade: A)

More time outside may decrease myopia progression. Less outdoor/sports activity before myopia onset may exert a stronger influence on the development of myopia than near work.[193] (Evidence Grade: B)

Outdoor time and near work do not have a major effect on myopia progression.[194] (Evidence Grade: B)

Higher levels of outdoor activity were associated with lower amounts of myopia in primary school students.[195] (Evidence Grade: D)

Potential Benefits:
Implementation of this recommendation is likely to help reduce the development and progression of myopia in children.

Benefit and Harm Assessment: Benefits significantly outweigh harms.	**Potential Risks/Harms:** None

Potential Costs: Direct cost of counseling as part of a pediatric eye and vision examination.

Value Judgments: None

Role of Patient Preferences: Moderate

Intentional Vagueness: Specific type/form of counseling is not stated, as it is patient specific.

Gaps in Evidence: Research is needed on the effects and possible interaction of outdoor activity and near work on myopia in children.

2. Coordination and Frequency of Care

The diagnosis of a wide array of eye and vision anomalies, diseases, disorders, and related systemic conditions may result from a comprehensive pediatric eye and vision examination. The nature and severity of the problem(s) diagnosed determine the need for:

- Optical correction
- Vision therapy
- Vision rehabilitation services
- Prescription or nonprescription medications
- Surgery
- Referral for consultation with or treatment by another doctor of optometry or other eye doctor (ophthalmologist), the patient's primary care physician, or other health care provider
- Follow-up for additional evaluation and/or treatment.

a. Coordination of Care

Based on the examination, it may be determined that the patient needs additional services. This may include:

- Intraprofessional consultation with another optometrist for treatment and management of ocular disease, vision rehabilitation, vision therapy, and/or specialty contact lenses.
- Interprofessional consultation with an ophthalmologist may be necessary for ophthalmic surgery or other aspects of secondary or tertiary eye care.
- Some vision problems can interfere with learning. Children at risk for learning-related vision problems should be evaluated by a doctor of optometry or other eye doctor (ophthalmologist).
- Referral for consultation with the child's pediatrician or other primary care physician, the school system, a child psychologist or psychiatrist, or the local or state Department of Special Education should be considered when problems in other developmental areas such as behavior, language, or social development are suspected or when a full psychoeducational evaluation is indicated.
- The comprehensive pediatric eye and vision examination may reveal non-ophthalmic conditions for which coordination of care may be needed. The patient may be referred to his or her pediatrician/primary care physician or another health care provider for further evaluation and treatment of systemic conditions or related health problems. Information shared with other health care providers offers a unique and important perspective resulting in an improved team approach to interdisciplinary care of the patient.
- Ocular telehealth programs may be a component of care for some patients, particularly in areas where access to specialized eye care services is limited. The use of ocular telehealth-based programs has the potential to expand access to eye care services; however, telehealth-based evaluations are not a substitute for an in-person comprehensive eye examination. These programs rely on the digital capture and transmission of standardized ocular images and patient health information at one location for interpretation and evaluation at another location by trained observers who can recommend a treatment and care plan. To date, telehealth programs have been most widely used for the evaluation of patients with diabetic retinopathy.[196] Telehealth may also offer a cost-effective screening method for retinopathy of prematurity[197] and follow-up of patients being treated for amblyopia.[198]

b. Frequency of Care

Children should receive periodic eye and vision examinations to diagnose and treat any eye disease in its early stages in order to prevent or minimize vision loss and maximize visual abilities. These examinations can also identify problems that may be affecting visual function and achievement at school, at home, and in sports or leisure activities. In addition, the early signs and symptoms of systemic medical conditions, such as diabetes, may be revealed during a comprehensive pediatric eye and vision examination.

The recommended frequency of a comprehensive pediatric eye and vision examination (Table 6) varies with a child's age, ocular and medical history, and other related risk factors.

- Infants and Toddlers (newborn through 2 years of age)

Clinical experience and research have shown that at 6 months the average child has reached a number of critical developmental milestones, making this an appropriate age for the first eye and vision examination. Within the first 6 months of life, rapid changes occur in most components of the visual system including visual acuity,[108, 199] accommodation,[200, 201] and binocular vision.[202-204] Since the developing visual system is considered most susceptible to interference during the first few years of life,[205-208] interference during this critical phase of development may have significant long-term effects; therefore, early diagnosis and treatment are critical to avoid vision loss.

There is a high prevalence of eye and visual problems in preterm children.[209] Preterm infants with a history of retinopathy of prematurity should be closely monitored for the development of high myopia, astigmatism, and anisometropia.[210] (Evidence Grade: B)

One of the primary goals of examining young children is to detect amblyopia so that treatment can be initiated as early as possible. Early visual examination in infants for amblyopia and amblyopia risk factors can lower the prevalence and severity of amblyopia in children.[211] (Evidence Grade: B)

Assessment of infant refractive error can identify not only vision problems, but also potential developmental difficulties. Infants with hyperopia may show deficits in many visuocognitive, spatial, visuomotor, and attention tests.[212] (Evidence Grade: B) Significant hyperopia (≥2 D) is commonly found in association with the early development of strabismus and amblyopia, with increased risk of development by age 4 years.

The wearing of a partial correction for significant hyperopia and anisometropia throughout infancy can reduce the incidence of poorer than average visual acuity in 3 to 5 1/2 year olds.[213] Spectacle correction in infancy also improves the chances of infants with hyperopia having normal vision at age 4 and beyond.

EVIDENCE-BASED ACTION STATEMENT: Infants should receive an in-person comprehensive eye and vision assessment between 6 and 12 months of age for the prevention and/or early diagnosis and treatment of sight-threatening eye conditions and to evaluate visual development.[210-212]

Evidence Quality: Grade B: Prospective cohort studies, Diagnostic study
Level of Confidence: High
Clinical Recommendation Level: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

Evidence Statements:
Preterm infants with a history of retinopathy of prematurity should be closely monitored for the development of high myopia, astigmatism and anisometropia.[210] (Evidence Grade: B)

Early visual examination in infants for amblyopia and amblyopia risk factors can lower the prevalence and severity of amblyopia in children.[211] (Evidence Grade: B) Assessment of infant refractive error can identify not only vision problems, but also potential developmental difficulties. Hyperopic infants may show deficits in many visuocognitive, spatial, visuomotor, and attention tests.[212] (Evidence Grade: B)	
Potential Benefits: Early identification and treatment of eye and vision problems.	**Potential Risks/Harms:** None
Benefit and Harm Assessment: Benefits significantly outweigh harms.	
Potential Costs: Direct cost of testing.	
Value Judgments: None	
Role of Patient Preferences: Moderate	
Intentional Vagueness: None	
Gaps in Evidence: None	

- Preschool Children (3 through 5 years of age)

Vision care in preschool children is very important because their visual system is still developing. They are at risk for the development of amblyopia, strabismus, and refractive error, which may lead to long term visual impairment. [2-5, 35, 214]

Amblyopia is a treatable condition in both children and adults;[49] (Evidence Grade: A) [51] (Evidence Grade: A) however, early diagnosis of amblyopia is particularly important, as there is evidence that treatment before 7 years of age leads to better long-term outcomes, whereas delaying treatment until age 7 or older reduces treatment outcomes.[215] Also, identifying strabismus at an early age may prevent the development of amblyopia and improve the chances of restoring binocularity.[57] Significant uncorrected refractive errors are a risk factor for the development of amblyopia. In addition to its impact on vision, amblyopia can affect an individual's psychosocial functioning, warranting early diagnosis and treatment.[17]

Uncorrected refractive errors have been associated with delays in development of cognitive ability and motor skill. [9, 212, 216] The Vision in Preschoolers-Hyperopia in Preschoolers (VIP-HIP) study found that uncorrected hyperopia ≥4.00D as well as uncorrected hyperopia ≥3.00D to ≤6.00D in conjunction with reduced binocular visual acuity (20/40 or worse) or reduced near stereoacuity (240 seconds of arc or worse) are associated with significantly worse performance on a test of early literacy (TOPEL) in 4 and 5 year old children.[217](Evidence Grade: C) Spectacle correction of children with astigmatism during the preschool years can also result in significantly improved best-corrected visual acuity by the time they reach kindergarten age.[218] (Evidence Grade: C)

Uncorrected vision problems can have a detrimental effect on vision development, learning, school success, and socialization, and many eye and vision problems are asymptomatic in this age range, Therefore, it is important that children receive a comprehensive eye examination. While the U.S. Preventive Services Task Force recommends that children have their vision screened at least once between the ages of 3 and 5 years;[98] (Evidence Grade: B), gaps exist in the delivery of preschool

vision screening. Rates of vision screening in preschool children are low, particularly in 3 year old children.[219] (Evidence Grade: C).

EVIDENCE-BASED ACTION STATEMENT: Preschool age children should receive an in-person comprehensive eye and vision examination at least once between the ages of 3 and 5 to prevent and/or diagnose and treat any eye or vision conditions that may affect visual development.[49, 51, 98, 217-219]
Evidence Quality: Grade B. Systematic Review, Case series, Cross-sectional study **Level of Confidence**: Medium **Clinical Recommendation Level**: Strong Recommendation. This recommendation should be followed, unless clear and compelling rationale for an alternative approach is present.
Evidence Statements: Amblyopia is a treatable condition in children and adults,[49] (Evidence Grade: A) [51] (Evidence Grade: A) however, delayed treatment may reduce treatment outcomes. Uncorrected hyperopia in 4 and 5 year old children has been associated with delays in the development of early literacy.[217] (Evidence Grade: C) Spectacle correction of astigmatism during the preschool years can result in significantly improved best-corrected visual acuity by kindergarten age.[218] (Evidence Grade: C) The U.S. Preventive Services Task Force recommends that children have their vision screened at least once between the ages of 3 and 5 years of age;[98] (Evidence Grade: B) however, gaps exist in the delivery of preschool vision screening and rates of screening are low, particularly in 3 year old children.[219] (Evidence Grade: C)
Potential Benefits: Early identification and treatment of eye and vision problems. / **Potential Risks/Harms:** None
Benefit and Harm Assessment: Benefits significantly outweigh harms.
Potential Costs: Direct costs of testing.
Value Judgments: None
Role of Patient Preferences: Moderate
Intentional Vagueness: None
Gaps in Evidence: None

- School-age Children (6 to 11 and 12 to 18 years of age)

Vision may change frequently during the school years. The most common problems are due to the development and progression of refractive errors. Myopia generally occurs in children during their early school years and increases in magnitude, as they get older. If myopia is defined as 0.50 D or more, the percentage of children becoming myopic is estimated to be 23.4 percent. The age at onset ranges from 7 to 16 years. Sixteen percent of children enrolled in the CLEERE study developed myopia (0.75D or more) during their school-age years.[36] The highest percentage of new cases occurred at age 11.

Children should receive an eye examination ~~by an eye doctor~~ at the beginning of primary school to diagnose the onset of myopia[101] (Evidence Grade: B) and, if diagnosed, they should have an examination at least annually or as frequently as their ~~eye~~ doctor recommends until the age of 12 because of rapid myopia progression.[220] (Evidence Grade: B) Children with myopia, especially those younger than 9 years of age and/or with two parents with myopia, are at higher risk for myopia progression and should be examined more than once per year.[192] (Evidence Grade: A)

In addition to its relationship to the development of strabismus and amblyopia, hyperopia can also affect the development of literacy skills. Children with uncorrected hyperopia show reduced performance in the acquisition of emergent literacy skills.[217] (Evidence Grade: C) [221] (Evidence Grade: C) Correction of hyperopia may, under specific conditions, lead to increased reading speed; therefore, eye examinations to diagnose uncorrected hyperopia are recommended.[222] (Evidence Grade: B)

An accommodative or vergence dysfunction can have a negative effect on a child's school performance, especially after third grade when the child must read smaller print and reading demands increase. Children with convergence insufficiency self-report more somatic (e.g., eyes hurt or headaches), visual (e.g., blur and diplopia), and performance (e.g., loss of concentration, frequent need to re-read and difficulty remembering what is read) problems compared to children with normal binocular vision.[223] Due to the discomfort of blurred or double vision, a child may not be able to complete reading or homework assignments and may be easily distracted or inattentive.

Studies have reported an association between reading and eye movements.[224-226] Efficient reading requires accurate eye movements. Treatment of children with eye movement problems has been shown to improve reading comprehension.[226]

Early diagnosis and treatment of an accommodative or vergence problem can reduce any negative impact on academic performance.[59] (Evidence Grade B) [227] Vision therapy has been shown to be effective in improving accommodative amplitude and accommodative facility in school-age children with symptomatic convergence insufficiency and accommodative dysfunction.[228] (Evidence Grade: A)

Children with Attention Deficit/Hyperactivity Disorder (AD/HD) or related learning problems may benefit from comprehensive vision evaluation to assess the presence of convergence insufficiency.[229] (Evidence Grade: D) Treatment of convergence insufficiency has been associated with reduction in the frequency of adverse academic behaviors.[59] (Evidence Grade B) [61,229]

(AOA Clinical Practice Guidelines web page)

EVIDENCE-BASED ACTION STATEMENT: School-age children should receive an in-person comprehensive eye and vision examination before beginning school to diagnose, treat, and manage any eye or vision conditions. [59, 101, 217, 221, 222, 228, 229]

Evidence Quality: Grade B. Prospective cohort studies, case-control study, cross-sectional study.
Level of Confidence: Medium
Clinical Recommendation Level: Strong Recommendation. This recommendation should be followed unless clear and compelling rationale for an alternative approach is present.

Evidence Statements: Children should receive an eye examination at the beginning of primary school to diagnose the onset of myopia.[101] (Evidence Grade: B)

Hyperopia can affect the development of literacy skills. Children with uncorrected hyperopia show reduced performance in the acquisition of emergent literacy skills.[217] (Evidence Grade: C) [221] (Evidence Grade: C)

Correction of hyperopia may, under specific conditions, lead to increased reading speed; therefore, eye examinations to diagnose uncorrected hyperopia are recommended.[222] (Evidence Grade: B) Early diagnosis of an accommodative or vergence problem can lead to more effective treatment [228] (Evidence Grade: A) and reduce the negative impact on academic performance.[59] (Evidence Grade: B). Children with AD/HD or related learning problems may benefit from comprehensive vision evaluation to assess the presence of convergence insufficiency.[229] (Evidence Grade: D) Treatment of convergence insufficiency has been associated with reduction in the frequency of adverse academic behaviors.[59] (Evidence Grade B)	
Potential Benefits: Early identification and treatment of eye and vision problems.	**Potential Risks/Harms:** None
Benefit and Harm Assessment: Benefits significantly outweigh harms.	
Potential Costs: Direct costs of testing.	
Value Judgments: None	
Role of Patient Preferences: Moderate	
Intentional Vagueness: None	
Gaps in Evidence: None	

EVIDENCE-BASED ACTION STATEMENT: Children with myopia should have an in-person comprehensive eye and vision examination at least annually, or as frequently as recommended, until age 12 because of the potential for rapid myopia progression.[192, 220]	
Evidence Quality: Grade B. Randomized clinical trial, prospective cohort study **Level of Confidence**: Medium **Clinical Recommendation Level**: Strong Recommendation. This recommendation should be followed, unless clear and compelling rationale for an alternative approach is present.	
Evidence Statements: Children with myopia should have an examination at least annually or as frequently as their ~~eye~~ doctor recommends until the age of 12 because of rapid myopia progression.[220] (Evidence Grade: B) When both parents have myopia, children are at higher risk for progression and should be examined more than once per year.[192] (Evidence Grade: A)	
Potential Benefits: Early identification and treatment of eye and vision problems.	**Potential Risks/Harms:** None

Benefit and Harm Assessment: Benefits significantly outweigh harms.
Potential Costs: Direct costs of testing.
Value Judgments: None
Role of Patient Preferences: Moderate
Intentional Vagueness: None
Gaps in Evidence: None

CONSENSUS-BASED ACTION STATEMENT: School-age children should receive an in-person comprehensive eye and vision examination annually to diagnose, treat, and manage any eye or vision problems.
Evidence quality: There is a lack of published research to support or refute the use of this recommendation.
Benefit and Harm Assessment: Implementing this recommendation is likely to result in earlier diagnosis and treatment of eye and vision problems and improved visual function. The benefits of this recommendation were established by expert consensus opinion.

c. At-risk Children

The extent to which a child is at risk for the development of eye and vision problems determines the appropriate re-evaluation schedule. Children with ocular signs and symptoms require a prompt comprehensive examination. Furthermore, the presence of certain risk factors may necessitate more frequent examinations, based on professional judgment. Factors placing an infant, toddler, or child at significant risk for eye and vision problems include:

- Prematurity, low birth weight, prolonged supplemental oxygen at birth
- Family history of amblyopia, strabismus, retinoblastoma, congenital cataracts, metabolic or genetic disease
- Infection of mother during pregnancy (e.g., rubella, toxoplasmosis, venereal disease, herpes, cytomegalovirus, or human immunodeficiency virus)
- Maternal smoking, use of alcohol, or illicit drug use during pregnancy
- Difficult or assisted labor, which may be associated with fetal distress
- High or progressive refractive error
- Strabismus
- Anisometropia
- Academic performance problems
- Known or suspected neurodevelopmental disorders

- Systemic health conditions with potential ocular manifestations
- Wearing contact lenses
- Having functional vision in only one eye
- Eye surgery or previous eye injury
- Taking prescription or nonprescription drugs (e.g., over the counter medications, supplements, herbal remedies) with potential ocular side effects

Table 6
Recommended Eye Examination Frequency for the Pediatric Patient**

	Examination Interval	
Patient Age	**Asymptomatic/ Low Risk**	**At-risk**
Birth through 2 years	At 6 to 12 months of age	At 6 to 12 months of age or as recommended
3 through 5 years	At least once between 3 and 5 years of age	At least once between 3 and 5 years of age or as recommended
6 to 18 years	Before first grade, and annually thereafter	Annually or as recommended

**The American Optometric Association Clinical Practice Guidelines provide more information on other eye and vision disorders and their risk factors. *(AOA Clinical Practice Guidelines web page)*

C. Conclusion

The prevalence of eye and vision disorders is substantial in children. Research indicates that early detection and intervention are particularly important in children because of the rapid development of the visual system in early childhood and its sensitivity to interference. When visual disorders such as amblyopia, strabismus, and significant refractive error are undetected, the long-term consequences can lead to significant vision loss, decreased educational and occupational opportunities and reduced quality of life. In addition, the cost of providing appropriate treatment for longstanding eye and vision disorders may be significantly higher than the cost of diagnosing and treating these problems early in life. A comprehensive pediatric eye and vision examination by a doctor of optometry or other eye doctor (ophthalmologist) is imperative for the timely diagnosis and treatment of eye and vision problems.

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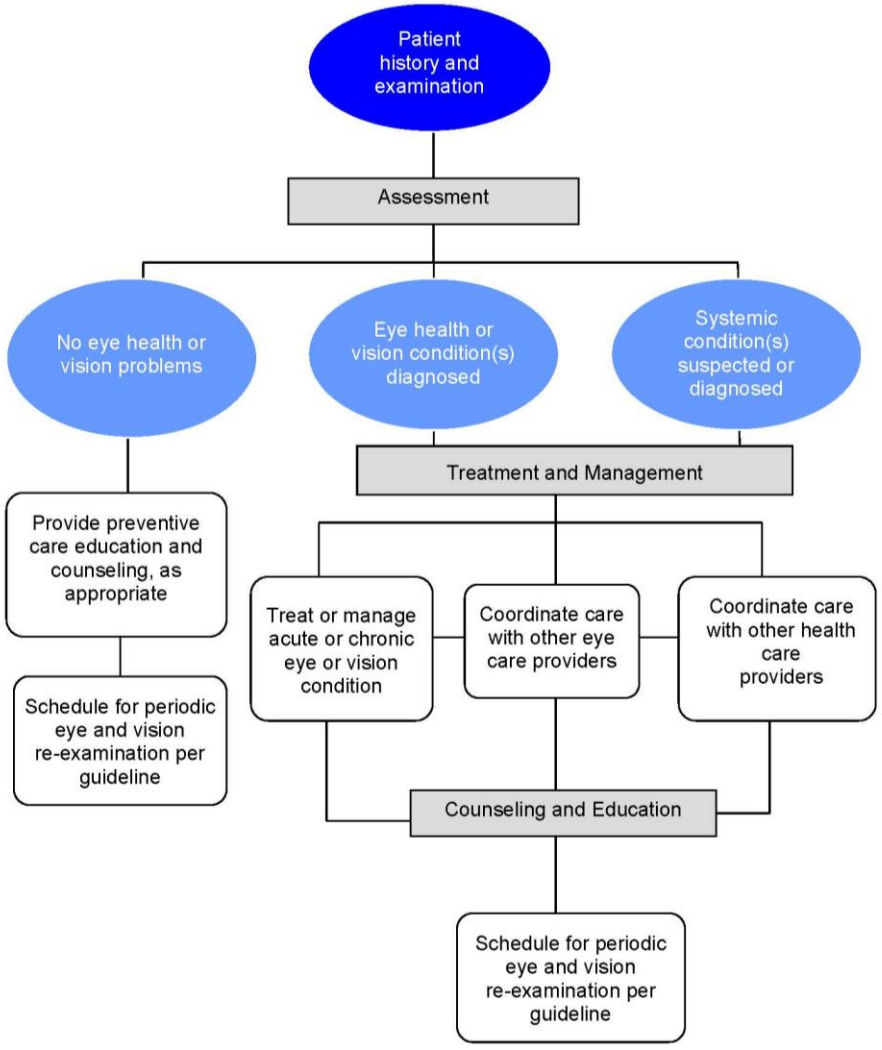
V. APPENDIX

A. Appendix Figure 1: Pediatric Eye and Vision Examination: A Flowchart



B. APPENDIX TABLE 1

Potential Components of the Comprehensive Eye and Vision Examination for Infants and Toddlers

A. Patient History

1. Nature and history of the presenting problem, including chief complaint
2. Visual and ocular history
3. General health history, including prenatal, perinatal, and postnatal history and review of systems
4. Medication reconciliation, including prescription and nonprescription drugs (e.g., over the counter medications, supplements, herbal remedies) and documentation of medication allergies

5. Family eye and medical histories
6. Developmental history of the child
7. Names of, and contact information for, the patient's other health care providers

B. Visual Acuity
1. Fixation preference test
2. Preferential looking visual acuity
3. Visual evoked potential

C. Refraction
1. Cycloplegic retinoscopy
2. Static (near) retinoscopy

D. Binocular Vision and Ocular Motility
1. Cover test
2. Brückner test
3. Stereopsis
4. Near point of convergence
5. Ocular motility assessment

E. Ocular and Systemic Health Assessment
1. Assessment of pupillary responses
2. Visual field evaluation (confrontation)
3. Evaluation of the ocular anterior segment and adnexa
4. Evaluation of the ocular posterior segment
5. Measurement of intraocular pressure

C. APPENDIX TABLE 2

Potential Components of the Comprehensive Eye and Vision Examination for Preschool Children

A. Patient History
1. Nature and history of the presenting problem, including chief complaint
2. Visual and ocular history
3. General health history, including prenatal, perinatal, and postnatal history and review of systems
4. Medication reconciliation, including prescription and nonprescription drugs (e.g., over the counter medications, supplements, herbal remedies) and documentation of medication allergies
5. Family eye and medical histories
6. Developmental history of the child
7. Names of, and contact information for, the patient's other health care providers

B. Visual Acuity
1. Symbol optotype or letter matching visual acuity testing

C. Refraction
1. Static (distance) retinoscopy
2. Cycloplegic retinoscopy
3. Autorefraction

D. Binocular Vision, Ocular Motility, and Accommodation
1. Cover test
2. Ocular motility assessment
3. Near point of convergence
4. Stereopsis
5. Positive and negative fusional vergences
6. Accommodative testing

E. Color vision testing

F. Ocular and Systemic Health Assessment
1. Assessment of pupillary responses
2. Visual field evaluation (confrontation)
3. Evaluation of the ocular anterior segment and adnexa
4. Evaluation of the ocular posterior segment
5. Measurement of intraocular pressure

D. APPENDIX TABLE 3

Potential Components of the Comprehensive Eye and Vision Examination for School-Age Children

A. Patient History
1. Nature and history of the presenting problem, including chief complaint
2. Visual and ocular history
3. General health history, including prenatal, perinatal, and postnatal history and review of systems
4. Medication reconciliation, including prescription and nonprescription drugs (e.g., over the counter medications, supplements, herbal remedies) and documentation of medication allergies
5. Family eye and medical histories
6. Developmental history of the child
7. School performance history
8. Names of, and contact information for, the patient's other health care providers

B. Visual Acuity
1. Snellen visual acuity
2. ETDRS visual acuity

C. Refraction
1. Static (distance) retinoscopy
2. Cycloplegic retinoscopy
3. Subjective refraction
4. Autorefraction

D. Binocular Vision, Ocular Motility, and Accommodation,
1. Cover test
2. Ocular motility assessment
3. Near point of convergence
4. Stereopsis
5. Positive and negative fusional vergences
6. Accommodative testing

E. Color Vision Testing

F. Ocular and Systemic Health Assessment
1. Assessment of pupillary responses
2. Visual field evaluation (confrontation)
3. Evaluation of the ocular anterior segment and adnexa
4. Evaluation of the ocular posterior segment
5. Measurement of intraocular pressure

E. Appendix Table 4

Partial Listing of Ocular Manifestations of Neurodevelopmental Disorders and Other Syndromes

Neurodevelopmental Disorders	Etiology	Associated Ocular Manifestations
Aicardi Syndrome	Dysgenesis of the corpus callosum	Chorioretinal lacunae, optic nerve colobomas, optic nerve hypoplasia
Alport Syndrome	Irregular synthesis of collagen	Fleck retinal dystrophy, anterior lenticonus, corneal dystrophy, cataracts
Angelman Syndrome	Deletion of maternal genetic material on chromosome 15	Strabismus, hypopigmentation of the choroid
Attention Deficit/ Hyperactivity Disorder	Genetic influences on dopaminergic systems, prenatal factors such as maternal use of drugs and alcohol	Convergence insufficiency, accommodative dysfunction, oculomotor disorders
Autism Spectrum Disorders	Unknown; possible link to environmental stressors, genetic mutations and inflammatory processes	Deficits in visual acuity, stereoacuity and ocular alignment; poor saccades and pursuits
Bardet-Biedl Syndrome	Mutation in 14 different genes that lead to problems with the function of cilia in cell structures	Reduced visual acuity, problems with night vision, tunnel vision
Batten-Mayou Syndrome	Autosomal recessive disorder resulting in accumulation of lipid	Lipofuscin accumulation in the retina, optic atrophy, macular pigment
Behçet's Disease	Postulated to be episodic hyperactivity of immune system	Uveitis, cataracts, optic atrophy, macular edema
Behr Syndrome	Autosomal recessive disease resulting in progressive deterioration of the nervous system	Optic atrophy, retrobulbar neuritis, nystagmus
Branchial Arch Syndrome	Disruption of neural crest cell migration	Strabismus, proptosis from poorly formed orbits, coloboma of the eyelid
Cerebral Palsy	Disorder of movement and posture secondary to damage to motor control connections	Strabismus, nystagmus, optic nerve pallor, cataracts, myopia
Cerebro-oculo-facial Syndrome	Autosomal recessive disorder resulting in defective swallowing mechanism	Microphthalmia, involuntary eye movements, congenital cataracts, blepharophimosis
Charot-Marie-Tooth Syndrome	Genetic anomaly resulting in progressive muscular atrophy	Nystagmus, diminished visual acuity

CHARGE Syndrome	Common mutation of chromosome 8 resulting in association of multiple systemic defects	Bilateral retinal coloboma involving the optic nerve, strabismus, amblyopia
Cri-du-chat Syndrome	Deletion of short arm of chromosome 5	Strabismus, hypertelorism, slanting of the palpebral fissure
Dandy-Walker syndrome	Absence of the cerebellar vermis and dilation of fourth ventricle	Papilledema often seen with hydrocephalus, ptosis and strabismus secondary to cranial nerve palsy
de Lange Syndrome	Mutation in genes responsible for chromosomal adhesions	Long eyelashes, ptosis telecanthus, alternating exotropia
Down Syndrome	Triplicate 21st chromosome	Epicanthal folds, upslanting palpebral fissure, high refractive error, strabismus, keratoconus, blepharitis
Dubowitz Syndrome	Unknown etiology	Strabismus, ptosis, telecanthus, epicanthal folds
Ehlers-Danlos Syndrome	Genetic or nutritional defects that have altered the biosynthesis of collagen	Lens subluxation, palpebral skin laxity, keratoconus, myopia, blue sclera, angiod streaks
Fetal Alcohol Syndrome	CNS damage secondary to alcohol crossing the blood-brain barrier	Telecanthus, strabismus, optic nerve hypoplasia, ptosis, microphthalmia
Fragile X Syndrome	Gene (FMR1) on the X chromosome fails to allow protein synthesis necessary for neural development	Strabismus, astigmatism, amblyopia
Gaucher Disease	Lysomal storage disease	Strabismus, gaze palsies, corneal clouding, pinquecula
Hunter Syndrome	Mucopolysaccharidosis I – Lysomal storage disease	Corneal clouding, pigmentary degeneration of the retina, optic atrophy
Lowe Syndrome	Abnormal protein transport within cellular membranes	Bilateral congenital cataracts, glaucoma, corneal keloids, strabismus
Prader-Willi Syndrome	Deletion of paternal genetic material on chromosome 15	Strabismus, almond-shaped palpebral fissures, myopia
Rett Syndrome	Mutation of binding protein (MECP2) that alters the development of gray matter	Difficulty maintaining eye contact
Spina Bifida	Incomplete closure of embryonic neural tube	Papilledema, nerve palsies, nystagmus, optic atrophy
Stickler Syndrome	Defective biosynthesis of collagen	Myopia, retinal detachments, vitreous anomalies
Usher Syndrome	Inherited autosomal recessive trait	Retinitis pigmentosa
Williams Syndrome	Vast deletion of genes on chromosome 7	Infantile esotropia, anomaly in visual-spatial relationship

Source: Adapted from Table 7.1 Rare Neurodevelopmental Disorders in Taub MB, Bartuccio M, Maino DM. Visual Diagnosis and Care of the Patient with Special Needs. Lippincott Williams & Wilkins, Philadelphia, PA, 2012.

F. Abbreviations/Acronyms

AD/HD	Attention Deficit/Hyperactivity Disorder
AHRQ	Agency for Healthcare Research and Quality
CI	Convergence insufficiency
CLEERE	Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error
CPG	Clinical Practice Guideline
D	Diopter
DR	Diabetic retinopathy
ERG	Electroretinogram
ETDRS	Early Treatment of Diabetic Retinopathy Study
FP	Fixation preference
G	Grams
GDG	Guideline Development Group
GDRG	Guideline Development Reading Group
IEP	Individualized Education Program
IOM	Institute of Medicine
IOP	Intraocular pressure
NPC	Near point of convergence
NRA	Negative relative accommodation
OCT	Optical coherence tomography
PRA	Positive relative accommodation
RCT	Randomized clinical trial
ROP	Retinopathy of prematurity
RP	Retinitis pigmentosa
SE	Spherical equivalent
TOPEL	Test of Preschool Early Literacy
VEP	Visual evoked potential
UV	Ultraviolet

USPSTF U.S. Preventive Services Task Force

VEP Visual evoked potential

VIP-HIP Vision in Preschoolers-Hyperopia in Preschoolers

G. Summary of Action Statements

Vision screenings have not been found to be an optimal means of identifying which children need eye and vision care and which do not. A comprehensive eye and vision examination can determine if a child does or does not have an eye or vision problem requiring treatment. Therefore, vision screenings should not be considered as a substitute for an in-person comprehensive eye and vision examination.[93-99] (Evidence Grade B/Strong Recommendation)

A comprehensive pediatric eye and vision examination should include, but is not limited to:

- Review of the nature and history of the presenting problem, patient and family eye and medical histories, including visual, ocular, general health, and developmental and school performance history of the child
- Measurement of visual acuity
- Determination of refractive status
- Assessment of binocular vision, ocular motility, and accommodation
- Evaluation of color vision (baseline or periodic, if needed, for qualification purposes or if disease related)
- Assessment of ocular and systemic health, including evaluation of pupillary responses, anterior and posterior segment, peripheral retina, and measurement of intraocular pressure and visual field testing. (Consensus)

Abnormal color vision can affect daily performance of activities involving color discrimination and may interfere with or prevent some occupational choices later in life. Children should be tested as soon as practical after 60 months (5 years) of age for color vision deficiency and the parents/caregivers of children identified with color vision deficiency should be counseled. (Consensus)

Children at risk for learning-related vision problems should be evaluated by a doctor of optometry or other eye doctor (ophthalmologist). (Consensus)

Many children with developmental or intellectual disabilities have undetected and untreated vision problems and should receive a comprehensive pediatric eye and vision examination. (Consensus)

Doctors of optometry and other eye doctors (ophthalmologists) should be aware of the eye-related findings associated with abusive head trauma and report findings of possible child abuse to the proper authorities, as defined by state law, for the protection of the child. (Consensus)

At the conclusion of a comprehensive pediatric eye and vision examination, the diagnosis should be explained to the patient/parent/caregiver and related to the patient's symptoms, and a treatment plan and prognosis discussed. (Consensus)

Parents/caregivers and children should be educated about potential risks for eye injuries at home, at school, and during sports and recreational activities and advised about safety precautions to decrease the risk of ocular injury.[177,183] Prevention of eye injuries in children should focus on the use of protective eyewear, parental supervision, and include education about both the risks of eye injury and the benefits of protective eyewear.[178] (Evidence Grade B/Strong Recommendation)

All children and their parents/caregivers should be advised about the benefits of the regular use of sunglasses that effectively block at least 99 percent of UVA and UVB radiation, the use of hats with brims when outdoors, and the importance of not looking directly at the sun. (Consensus)

Patients/parents/caregivers should be counseled about the benefits to children's vision of spending more time outdoors**.**[192-195] (Evidence Grade B/Recommendation)

Infants should receive an in-person comprehensive eye and vision assessment between 6 and 12 months of age for the prevention and/or early diagnosis and treatment of sight-threatening eye conditions and to evaluate visual development [210-212] (Evidence Grade B/Strong Recommendation)

Preschool age children should receive an in-person comprehensive eye and vision examination at least once between the ages of 3 and 5 to prevent and/or diagnose and treat any eye or vision conditions that may affect visual development.[49,51,98,217-219] (Evidence Grade B/Strong Recommendation)

School-age children should receive an in-person comprehensive eye and vision examination before beginning school to diagnose, treat and manage any eye or vision conditions.[59,101,217,221,222,228,229] (Evidence Grade B/Strong Recommendation)

Children with myopia should have an in-person comprehensive eye and vision examination at least annually, or as frequently as recommended until age 12, because of the potential for rapid myopia progression.[192,220] (Evidence Grade B/Strong Recommendation)

School-age children should receive an in-person comprehensive eye and vision examination annually to diagnose, treat, and manage eye or vision problems. (Consensus)

H. Gaps in Research Evidence

During the course of the development of this guideline, the Evidence-Based Optometry Guideline Development Group identified the following gaps in evidence as potential areas for future research:

- Research to compare the outcomes of vision screenings versus comprehensive eye and vision examinations
- Research to determine the risks and protective factors associated with eye injuries in children in order to design appropriate prevention strategies
- Research on the effects and possible interaction of outdoor activity with near work and myopia in children.

VI. METHODOLOGY FOR GUIDELINE DEVELOPMENT

This guideline was developed by the AOA Evidence-Based Optometry Guideline Development Group (GDG). Clinical questions to be addressed in the guideline were identified and refined during an initial meeting of the GDG and served as the basis for a search of the clinical and research literature.

An English language literature search for the time period January 1990 to December 2015 was conducted by trained researchers.

If the search did not produce results, the search parameters were extended an additional 5 years, and subsequently 10 years back. In addition, a review of selected earlier research publications was conducted based on previous versions of this guideline. The literature search was conducted using the following electronic databases:

- Agency for Healthcare Research and Quality (AHRQ)
- Centers for Disease Control and Prevention, National Center for Health Statistics
- Cochrane Library
- Elsevier
- Google Scholar
- Medline Plus
- National Eye Institute
- National Guideline Clearinghouse
- PubMed

A chart listing numbers of articles retrieved and reviewed to be added here

All references meeting the criteria were reviewed to determine their relevance to the clinical questions addressed in the guideline. Each article was assigned to two clinicians who independently reviewed and graded the quality of evidence and the clinical recommendations for the article, based on a previously defined system for grading quality. If discrepancies were found in the grading results, the article was assigned to an independent third clinician for review and grading.

During articulation meetings of the Evidence-Based Optometry Guideline Development Reading Group (GDRG), all evidence was reviewed and clinical recommendations were developed. Grading for the recommendations was based on the quality of the research and the benefits and risks of the procedure or therapy recommended. Where direct scientific evidence to support a recommendation was weak or lacking, a consensus of the Evidence-Based Optometry Subcommittee members was required to approve a recommendation.

At the Draft Reading Meeting of the Evidence-Based Optometry GDG, the guideline document was reviewed and edited, and the final draft was reviewed and approved by the GDG by conference call. The final draft of the guideline was then made available for peer and public review for 30 days for numerous stakeholders (individuals and organizations) to make comments. All suggested revisions were reviewed, and, if accepted by the GDG, incorporated into the guideline.

Clinical recommendations in this guideline are Evidence-Based statements regarding patient care that are supported by the scientific literature or consensus of professional opinion when no quality evidence was discovered. The guideline will be periodically reviewed and updated as new scientific and clinical evidence becomes available.

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