OPTOMETRIC CLINICAL PRACTICE GUIDELINE

Pediatric Eye And Vision Examination

American Optometric Association

OPTOMETRY: THE PRIMARY EYE CARE PROFESSION

Doctors of optometry are independent primary health care providers who examine, diagnose, treat, and manage diseases and disorders of the visual system, the eye, and associated structures as well as diagnose related systemic conditions.

Optometrists provide more than two-thirds of the primary eye care services in the United States. They are more widely distributed geographically than other eye care providers and are readily accessible for the delivery of eye and vision care services. There are approximately 32,000 full-time equivalent doctors of optometry currently in practice in the United States. Optometrists practice in more than 7,000 communities across the United States, serving as the sole primary eye care provider in more than 4,300 communities.

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 the quality of life.

Healthy People 2010 Vision

American Optometric Association

OPTOMETRIC CLINICAL PRACTICE GUIDELINE
PEDIATRIC EYE AND VISION EXAMINATION

Reference Guide for Clinicians

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NOTE: Clinicians should not rely on the Clinical Guideline alone for patient care and management. Refer to the listed references and other sources for a more detailed analysis and discussion of research and patient care information. The information in the Guideline is current as of the date of publication. It will be reviewed periodically and revised as needed.

TABLE OF CONTENTS

INTRODUCTION

Optometrists, through their clinical education, training, experience, and broad geographic distribution, have the means to provide effective primary eye and vision services to children in the United States. Primary care has been described as those services provided to patients by a health care practitioner "who knows them, who is available for first contact and continuing care, and who offers a portal of entry to specialists for those conditions warranting referral."[1] Eye care serves as an important point of entry into the health care system because:

- Virtually all people need eye care services at some time in their lives.
- By its very nature, eye care provides for the evaluation, assessment, and coordination of a broad spectrum of health care needs.
- Eye care is a nonthreatening form of health care, particularly to patients who are reluctant to seek general or preventive medical care.[2]

This Optometric Clinical Practice Guideline for the Pediatric Eye and Vision Examination describes appropriate examination procedures for evaluation of the eye health and vision status of infants and children to reduce the risk of vision loss and facilitate normal visual development. It contains recommendations for timely diagnosis, intervention, and, when necessary, consultation or referral for treatment by another health care provider. This Guideline will assist optometrists in achieving the following goals:

- Develop an appropriate timetable for eye and vision examinations for pediatric patients
- Select appropriate examination procedures for all pediatric patients
- Examine the eye health and visual status of pediatric patients effectively
- Minimize or avoid the adverse effects of eye and vision problems in children through early identification, education, treatment, and prevention
- Inform and educate patients, parents/caregivers, and other health care providers about the importance and frequency of pediatric eye and vision examinations.

I. STATEMENT OF THE PROBLEM

In 2000 the U.S. Census Bureau reported that there were 72.3 million children under 18 years of age in the United States (26% of the population) and the numbers in this age group, with its growth rate of 13.7 percent, were increasing faster than in any other segment of the population.[3] Vision disorders are the fourth most common disability in the United States and the most prevalent handicapping condition during childhood.[4] In spite of the high prevalence of vision disorders in this population, studies show that only about 31 percent of children between ages 6 and 16 years are likely to have had a comprehensive eye and vision examination within the past year, while below the age of 6, only about 14 percent are likely to have had an eye and vision examination.[5] In a study of 5,851 children 9 to 15 years of age, nearly 20 percent needed glasses but only 10 percent of that group already had them.[6] Thus, 90 percent of those children requiring prescription eyeglasses were not wearing them. Why so few children receive professional eye care is unknown. Possible explanations include a reliance on pediatricians, other primary care physicians, or school screenings, many uninsured parents' or caregivers' inability to pay for the needed services, and parents' or caregivers' lack of knowledge that early professional eye care is needed to prevent unnecessary loss of vision as well as to improve educational readiness.

Unfortunately, undue reliance on vision screening by pediatricians or other primary care physicians may result in the late detection of amblyopia and other vision disorders. One study reported that in a sample of 102 private pediatric practices in the United States, vision screening was attempted on only 38 percent of 3-year-old children and 81 percent of 5-year-old children. The study also showed that only 26 percent of children failing the American Academy of Pediatrics vision screening guidelines were referred for a professional eye examination.[7] The American Public Health Association adopted a resolution that recognizes the shortcomings of vision screenings, encourages regular eye examinations at the ages of 6 months, 2 years, and 4 years, and urges pediatricians to recommend that all children receive eye examinations at these intervals.[8] Healthy People 2010, a national disease prevention initiative of the U.S. Department of Health and Human Services, also

recognizes the importance of preventive vision care.[9] One of its goals is to improve the visual health of the Nation through prevention, early detection, treatment, and rehabilitation. These national efforts to inform the public about the importance of early eye care and the current limitations of vision screening are issues that all optometrists need to discuss within every community until all children receive professional eye examinations on a regular basis throughout childhood (see Table 1).

Table 1

COMPARISON OF RECOMMENDED COMPONENTS FOR A PEDIATRIC COMPREHENSIVE EYE EXAMINATION VERSUS A VISION SCREENING

	Comprehensive Eye Examination		Vision Screening				
	AOA[1]	**AAO[2]**	**Modified Clinical Technique[3]**	**School Nurses[4]**	**AAP[5]**	**PBA[6]**	**Head Start[7]**
Patient history							
Chief complaint	X	X					
Visual and ocular history	X	X		Observation		Observation	
General health history	X	X					
Family medical history	X	X					
Developmental history	X	X					
Visual acuity measurement	X	X	X	X	X	X	X
Measurement of refractive error							
Retinoscopy	X	X	X	Plus lens test			
Cover test	X	X	X	X	X	Optional	X
Near point of convergence	X						
Stereopsis	X			X	X	Optional	
Positive and negative fusional vergences	X						
Versions	X	X		Tracking			

The interrelationships between vision problems and learning difficulties and the cost of undetected vision problems to society are of concern.[10] Vision problems generally are not the direct cause of learning disorders; however, they can interfere with children's abilities to perform to their potential. When children fail to progress in school, the cost to the individual and society can be substantial.

Over the past 30 years, studies have shown the need for earlier eye examination and treatment and have resulted in clinical advances that enable more effective preventive eye care for infants and preschool children.[11-21] Extensive research has demonstrated the importance of the first few years of life in the development of vision. Within the first 6 months of life, rapid changes occur in most components of the visual system including visual acuity,[11,12] accommodation,[13,14] and binocular vision.[15-17] Interference with development during this very critical phase may lead to serious lifelong effects on vision.[18] Successful treatment can be obtained more quickly with early intervention.[21-24]

An outgrowth of this research is the development of new clinical procedures appropriate for the evaluation of vision in infants and toddlers.[17,25-36] Clinicians have gained a better understanding of both the characteristics and processes of vision development in infants and the tools necessary to examine them. As a result, it is now recommended that all children receive regular, professional eye care beginning at 6 months of age after an initial eye screening at birth, typically performed by the pediatrician.[8,37]

A. Epidemiology of Eye and Vision Disorders In Children

One of the largest studies reporting the prevalence of specific vision disorders in children was conducted as part of the Health Examination Surveys of 1963-65.[38] Data were collected from a sample of 7,119 noninstitutionalized children 6-11 years of age who received standardized eye examinations. Of the children examined, 9.2 percent had an eye muscle imbalance, a disease condition, or other abnormality in one or both eyes. Approximately 2.4 percent had constant strabismus and 4.3 percent had significant heterophoria. The combined prevalence

of eyelid conditions (hordeola, conjunctivitis, and blepharitis) was about 1 percent.

The second phase of that research project determined the prevalence of eye disorders in 12- to 17-year-olds.[39] Of the 6,768 children examined, 7.9 percent had an eye muscle imbalance, a disease condition, or other abnormality in one or both eyes; approximately 3.4 percent had constant strabismus, and 1.8 percent had significant heterophoria. The prevalence of conjunctivitis was 0.6 percent, and that of blepharitis, 0.3 percent.

A more recent review of the literature found the following prevalence figures for eye and vision problems in children: amblyopia, 2-3 percent; strabismus, 3-4 percent; refractive errors, 15-30 percent; and ocular disease, less than 1 percent.[40] A large-scale prospective study of the prevalence of vision disorders and ocular disease focused on a clinical population of children between the ages of 6 months and 18 years. Comprehensive eye examinations performed on 2,025 consecutive patients showed that, in addition to refractive anomalies, the most common conditions optometrists are likely to encounter in this population are binocular vision and accommodative disorders (see Table 2).[41]

Table 2
Vision Disorders in a Clinical Population of Children

Disorder	Prevalence* Ages 6 months to 5 years 11 months	Ages 6 years to 18 years
Hyperopia	33%	23%
Astigmatism	22.5%	22.5%
Myopia	9.4%	20.2%
Nonstrabismic binocular disorders	5.0%	16.3%
Strabismus	21.1%	10%
Amblyopia	7.9%	7.8%
Accommodative disorders	1.0%	6.0%
Peripheral retinal abnormalities requiring referral or followup care	0.5%	2.0%

- Findings are based on a specialized clinical population and may not be representative of vision problems in the general population.

Source: Scheiman M, Gallaway M, Coulter R, et al. Prevalence of vision and ocular disease conditions in a clinical pediatric population. J Am Optom Assoc 1996; 67:193-202.

B. The Pediatric Eye and Vision Examination

The term “pediatric population" can be applied to patients within a broad age range, including all those between birth and 18 years of age. Although the capabilities and needs of children vary significantly, the pediatric population can be divided into three subcategories:[42-44]

- Infants and toddlers (birth to 2 years, 11 months)
- Preschool children (3 years to 5 years, 11 months)
- School-age children (6 to 18 years).

This subdivision of the pediatric population is based on the developmental changes that occur from birth through childhood. 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. At this age the average child can sit up with support and cognitively is concerned with immediate sensory experiences.[45] Visual acuity,[12] accommodation,[13,14] stereopsis, and other aspects of the infant’s visual system have developed rapidly, reaching adult levels by the age of 6 months (see Table 3).[15,25]

TABLE 3

VISUAL DEVELOPMENT INVENTORY

VISUAL DEVELOPMENT INVENTORY	Newborn	1 Month	2 Months	4 Months	6 Months	9 Months	12 Months	18 Months	24 Months	3 Years
OCULOMOTOR										
Fixation	To face →									
Saccades										
H	⊕ →								One shift	
V	⊖	⊖	⊕ →						to target	
Pursuits	⊖	⊖	Emerging	⊕ →						
Visually directed reaching	⊖	⊖	⊖	?	⊕ →					
Face regard	⊕ →									
OKN: T-N and N-T response	Asymmetric ⊕ →	Asymmetric	Asymmetric	Asymmetric	Symmetric →					
ACUITY	20/400	20/300	20/150		20/50			20/40	20/30	20/20
Preferential	to	to	to →		to →		→	to	to	
Looking OU	20/1200	20/1200	20/600		20/200			20/100	20/80	
Visual Evoked Response VEP OU	20/100	20/200	20/80		20/40					
BINOCULARITY								Adultlike levels		
Alignment		⊕ →					→	of Angle Lambda	→	
Near point of convergence	Up to 10 in →			→	To nose →					
Fixation of moving target	⊖	⊖		Response ⊕ →						
10 Δ response	⊖	⊖			70% of time →					
Stereopsis	None			Emerging	Well developed					
ACCOMMODATION				Well developed						
Accuracy	Accurate for 30 cm (12 in)				Accurate for 75 to 150 cm →					
Lag				+0.75 →						
PUPIL RESPONSES	⊕Sluggish	Well developed →								
Color Vision	Notices color Can't distinguish R, G, or Y		Distinguishes R-G not Y-G	Recognizes similar hues within color group						Normal
Blink response to visual threat			⊕ →							
Contrast sensitivity function			Adult-like low frequency attenuation							Adult-like btwn 3-5 yr

Key: ⊕ Emerging R = Red
⊖ Not existing G = Green
→ Continues Y = Yellow

(Courtesy of Dr. Janice Scharre, Illinois College of Optometry, Chicago.)

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, the examiner often needs to make modifications in the testing to gather useful information. By 6 years of age, the child has matured to the point that many adult tests can be used, with minor procedural modifications. 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.

The goals of the pediatric eye and vision examination are several (see Appendix Figure 1):

- Evaluate the functional status of the eyes and visual system, taking into account each child's level of development
- Assess ocular health and related systemic health conditions
- Establish a diagnosis and formulate a treatment plan
- Counsel and educate parents/caregivers regarding their child's visual, ocular, and related health care status, including recommendations for treatment, management, and preventive care.

[redacted]

[redacted]

II. CARE PROCESS

A. Examination of Infants and Toddlers

1. General Considerations

This section of the Guideline describes optometric procedures for examining infants and toddlers from birth to 2 years, 11 months of age. The examination components are described in general terms and are not intended to be all inclusive. Professional judgment and individual patient symptoms, findings, and cooperation may have significant impact on the nature and course of the examination.

Children in this age group generally perform best if the examination takes place when they are alert. Examination early in the morning or after an infant's nap is usually most effective. Because infants tend to be more cooperative and alert when feeding, it is also helpful to suggest that the parent bring a bottle for the child.

Age-appropriate examination and management strategies should be used. Major modifications include relying more on objective examination procedures and performing tests considerably more rapidly than with older children.[43]

2. Early Detection and Prevention

Early detection and treatment are essential to preventing vision conditions that have the potential to cause permanent loss of vision. Screening by the 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, screening this population has been problematic, leading to underdetection of strabismus, amblyopia, and significant refractive error.[5,46] Newer screening techniques such as photorefraction are available,[36, 47-50] but until they are validated, an eye and vision examination at 6 months of age is the best approach for early detection and prevention of eye and vision problems in infants and toddlers (see Table 3).

3. Examination Sequence

The eye and vision examination of the infant or toddler may include, but is not limited to, the following procedures (see Appendix Figure 2):

a. Patient History

A comprehensive patient history for infants and toddlers may include:

- Nature of the presenting problem, including chief complaint
- Visual and ocular history
- General health history, including prenatal, perinatal, and postnatal history and review of systems
- Family eye and medical histories
- Developmental history of the child.

The collection of demographic data generally precedes the taking of the patient history. Having the parent(s) fill out a questionnaire facilitates obtaining the patient history.[43] Responses to questions related to the mother's pregnancy, birth of the child, and the child's general and vision development will help direct the remainder of the examination.

b. Visual Acuity

Assessment of visual acuity for infants and toddlers may include these procedures:

- Fixation preference tests
- Preferential looking visual acuity test.

Estimation of visual acuity in an infant or toddler can help to confirm or reject certain hypotheses about the level of binocularity and provides direction for the remainder of the examination. Because subjective visual acuity testing requiring verbal identification of letters or symbols demands sustained attention, this test cannot be used with infants and toddlers. However, other tests may be used to make assumptions about visual acuity. For example, when a unilateral, constant strabismus is present, visual acuity is presumed to be reduced in the strabismic eye. In

the presence of a constant, alternating strabismus, visual acuity is likely to be normal in both eyes.

In the absence of strabismus, fixation preference testing with a vertical base up or base down 10 prism diopter (PD) lens to create diplopia has been shown to be effective in detecting about a three-line visual acuity difference between the eyes and identifying moderate to severe amblyopia.[51] Specific clinical guidelines have been developed to estimate visual acuity on the basis of the strength of fixation preference.[52, 53] A study of fixation preference testing demonstrated that the fixation pattern can be rapidly assessed and confirmed the usefulness of a graded assessment of the binocular fixation pattern in the detection of amblyopia.[54]

Before the advent of behavioral and electrophysiological procedures, indirect methods were all that were available to clinicians for assessing visual acuity in preverbal children. As more direct assessment procedures were developed, it became evident that although fixation preference is helpful in detecting amblyopia, it is not always an accurate predictor of visual acuity. Preferential looking acuity and fixation preference do not show a strong association.[55,56]

Clinical use of preferential looking acuity is generally very successful. Teller acuity cards can be used with infants and young children until they are ready for more subjective testing.[33,57-59] However, underestimation of visual acuity loss in patients with strabismic amblyopia on the basis of grating acuity (preferential looking acuity) limits the usefulness of this test.[60-65] When in doubt, the optometrist can refer the child for electrodiagnostic testing, such as visual evoked potentials, which has been shown to be an important method for direct assessment of visual acuity in infants.[66-68]

If clinical evaluation of an infant or toddler by indirect visual acuity testing, refraction, and ocular health assessment indicates any problem with visual acuity, forced-choice preferential looking with the Teller acuity cards or electrodiagnostic testing should be considered to obtain a more precise measure of baseline visual acuity. Consultation with an optometrist or ophthalmologist who has advanced clinical training or

experience with preferential looking assessment or electrophysiological evaluation of visual acuity may be warranted.

c. Refraction

Traditional subjective procedures for the assessment of refractive error may be ineffective with infants or toddlers because of short attention span and poor fixation.[69] As a result, the examiner will need to rely on objective measures of refraction. The two most commonly used procedures are:

- Cycloplegic retinoscopy
- Near retinoscopy.

It is important for the examiner performing cycloplegic retinoscopy in an infant or toddler to take several precautions:[70]

- Select the cycloplegic agent carefully (e.g., fair-skinned children with blue eyes may exhibit an increased response to drugs and darkly pigmented children may require more frequent or stronger dosages).
- Avoid overdosage (e.g., children with Down syndrome, cerebral palsy, trisomy 13 and 18, and other central nervous system disorders in whom there may be an increased reaction to cycloplegic agents, 1% tropicamide may be used).
- Be aware of biologic variations in children (e.g., low weight infants may require a modified dosage).

Cyclopentolate hydrochloride*[1] is the cycloplegic agent of choice. One drop should be instilled twice, 5 minutes apart, in each eye, using a strength of 0.5% for children from birth to 1 year and 1% for older children.[71] Spray administration of the drug appears to be a viable alternative to the use of conventional eye drops for routine cycloplegic retinoscopy in the pediatric population.[72-74] The child is asked to keep

*Every effort has been made to ensure that drug dosage recommendations are accurate at the time of publication of this Guideline. However, treatment recommendations change due to continuing research and clinical experience, and clinicians should verify drug dosage schedules with product information sheets.

his or her eyes gently closed while the examiner sprays the cycloplegic agent on the child's eyelids. As the child blinks, enough of the drug is delivered to the eye to provide adequate cycloplegia. This technique has two advantages: (1) The child has less of an avoidance response, and it may be less traumatic for the child and the parent observing the procedure. (2) A single application can achieve both cycloplegia and pupillary dilation when a mixture of 0.5% cyclopentolate, 0.5% tropicamide, and 2.5% phenylephrine is used. To maintain sterility, it is best to have this spray mixture prepared by a pharmacist. Retinoscopy may be performed 20-30 minutes after instillation.[72] The use of loose lenses or a lens rack is recommended for retinoscopy.

A study comparing retinoscopy in infants using near retinoscopy, cycloplegia with tropicamide 1%, and cycloplegia with cyclopentolate 1% found that tropicamide may be a useful alternative in many healthy, nonstrabismic infants.[75]

Near retinoscopy is another objective method of estimating refractive error in infants and toddlers.[30] However, it has not been found reliable for quantification of the refractive error.[76-78]

Near retinoscopy may have some clinical value in the following situations:

- When frequent followup is necessary
- When the child is extremely anxious about instillation of cycloplegic agents
- When the child has had or is at risk for an adverse reaction to cyclopentolate or tropicamide.

The average refractive error in children from birth to 1 year of age is about 2 diopters (D) of hyperopia (standard deviation 2 D).[79] Astigmatism up to 2 D is common in children under 3 years of age. Studies show that 30-50 percent of infants less than 12 months of age have significant astigmatism, which declines over the first few years of life, becoming stable by approximately 2½ to 5 years of age.[80-81] Low amounts of anisometropia are common and variable in infants. The clinician may choose to monitor these levels of refractive error rather than prescribe a lens correction.

d. Binocular Vision and Ocular Motility

The following procedures are useful for assessing binocular function:

- Cover test
- Hirschberg test
- Krimsky test
- Brückner test
- Versions
- Near point of convergence.

The cover test is the procedure of choice for evaluation of binocular vision in preverbal children because it is objective and requires little time to administer. If the cover test results are unreliable because of the child's resistance to testing, other methods may be used. In such cases, use of the Hirschberg test is often successful in infants 6 months and younger. Prisms can be used with the Hirschberg test to align the corneal reflections (Krimsky test) and determine the magnitude of the deviation.

The Brückner test is another means of objectively assessing binocular vision, as well as providing an indirect evaluation of refractive error. When both eyes are simultaneously illuminated with the ophthalmoscope beam at a distance of 100 cm, an overall whitening of the red reflex across the entire pupil of one eye indicates strabismus or anisometropic amblyopia. While the absence of a Brückner reflex is not a good indication of alignment, the presence of a Brückner reflex is considered a positive result, and is a good indication of strabismus, even of small amounts. Once detected with the Brückner reflex, the deviation should be quantified with the cover test or Krimsky technique.

Additional binocular testing often can be performed successfully with infants and toddlers. For example, preferential looking techniques can be used to assess stereopsis with some success.[17, 82,83]

Assessment of extraocular muscle function and concomitancy may involve version testing with an appropriate target. If the infant will follow a penlight, observation of the corneal reflections in all cardinal positions of gaze is possible. When a problem is suspected, the cover

test procedure should be used for the position of gaze in question. After performing version testing, the clinician may find it useful to move the penlight or other target toward the child to assess objectively the near point of convergence (NPC).

If a binocular vision disorder or an ocular motility problem is suspected, consultation with an optometrist or ophthalmologist who has advanced clinical training or experience with this population may be warranted.

e. Ocular Health Assessment and Systemic Health Screening

An evaluation of ocular health may include:

- Evaluation of the ocular anterior segment and adnexa
- Evaluation of the ocular posterior segment
- Assessment of pupillary responses
- Visual field screening (confrontation).

The diagnosis of eye disease in infants and toddlers presents some unique challenges. Standard procedures such as biomicroscopy, tonometry, and binocular indirect ophthalmoscopy are considerably more difficult in this population.

The cover test and versions, both important binocular vision assessment procedures, are also important for ocular health assessment. For example, the presence of strabismus may indicate any number of disease entities such as neoplasm, neuromuscular disorder, infection, vascular anomaly, or traumatic damage.[84]

The examiner performing external ocular evaluation should gather as much information as possible by gross inspection of the eyes and adnexa. Generally, children up to the age of 6-9 months are sufficiently attracted to lights to permit adequate evaluation using a penlight or transilluminator. With the older infant, it is important to use a variety of interesting targets that can be attached to the transilluminator.[84] Pupil function (direct, consensual, and afferent pupil integrity) should also be evaluated.

A hand-held biomicroscope may be used for evaluation of the anterior segment or the parent/caregiver may be able to position and hold the infant or toddler in a standard biomicroscope. If a corneal problem is suspected, but use of the biomicroscope is impossible, the optometrist may attempt an examination using sodium fluorescein and a Burton lamp. Another simple alternative is to use a self-illuminated, hand-held magnifying lens, or a 20 D condensing lens with a light source.

Thorough evaluation of the ocular media and the posterior segment generally requires pupillary dilation. Recommended drugs and dosages for pupillary dilation in infants and toddlers are one drop each of tropicamide (0.5%) or cyclopentolate (0.5%) and one drop of phenylephrine (2.5%).[84] The spray mixture discussed previously is effective in achieving both dilation and cycloplegia in the pediatric population.[72] Both direct and binocular indirect ophthalmoscopy may be performed after the pupil has dilated. An ideal time for evaluation of the posterior segment is when the infant is in a calm, relaxed, sedated condition (i.e., being bottle fed or sound asleep).[44] When adequate fundus examination is impossible but is indicated by patient history, examination under sedation or anesthesia may be warranted.

Measuring intraocular pressure (IOP) is not a routine part of the eye examination of the infant or toddler. Although it is extremely rare in this age group, glaucoma may be suspected in the presence of a number of signs (e.g., corneal edema, increased corneal diameter, tearing, and myopia). Measurement of IOP is difficult and the results often are unreliable.[43,85] However, pressure should be assessed when ocular signs and symptoms or risk factors for glaucoma exist. Measurement of IOP in the pediatric population may be accomplished with hand-held applanation and noncontact tonometers. If risk factors are present and reliable assessment of IOP under standard clinical conditions is impossible, testing under sedation may be appropriate.

When strabismus or other neurological problems are suspected, confrontation visual fields should be attempted with infants and toddlers using a variation of the traditional approach.[86] A shift in fixation, head movement toward the target, or change in facial expression of the infant can indicate that the target has moved from an unsighted to a sighted

field.[43] The clinician should decide when imaging studies are indicated, independently or in consultation with a neurosurgeon or neurologist, on the basis of risk factors and the observation of ocular abnormalities, or signs such as nystagmus, developmental delay, poor growth, regression of skills, and seizures.

During the ocular health assessment and systemic health screening of infants and children of any age, it is important to remember that health care providers are responsible for recognizing and reporting signs of child abuse, a significant problem in the United States. Between 1990 and 1994 reported child abuse cases increased 27 percent, from 800,000 to 1,012,000, with almost half of the victims under the age of 6 years.[87]

Optometrists have a uniquely important role in diagnosing child abuse including Shaken Baby Syndrome (SBS) because external eye trauma, and retinal trauma (hemorrhages, folds, tears, detachments, and schisis) are common ocular findings from child abuse.[88-90] SBS is a specific term used to describe a form of child abuse in which the child is injured secondary to violent shaking, which often causes retinal hemorrhaging. Most often the child is between 2 and 18 months of age at the time of abuse.[91,92]

In many states, optometrists must report suspected child abuse or neglect to the state child welfare service. Failure to report a suspected case of child abuse puts that child, his or her other siblings, and possibly a parent/caregiver in danger of continued abuse at home.

f. Assessment and Diagnosis

Upon completion of the examination, the optometrist assesses and evaluates the data to arrive at one or more diagnoses and establishes a management plan. In some cases, referral for consultation with or treatment by another optometrist, the patient's pediatrician, primary care physician, or other health care provider may be indicated.

B. Examination of Preschool Children

1. General Considerations

This section of the Guideline describes the optometric examination procedures for preschool children. The examination components are discussed in general terms and are not intended to be all inclusive. Professional judgment and individual patient history, symptoms, findings, and cooperation may have significant impact on the nature and course of the examination.

Although the vast majority of children in this age group can communicate verbally, it is preferable in most cases for the parent/caregiver to accompany the child into the examination room. It is important to ensure that the child feels relaxed and at ease, which is often best accomplished by beginning the examination with procedures that appear less threatening.

Age-appropriate examination and management strategies should be used with preschool children. Major modifications include reliance on objective examination techniques, limited use of subjective techniques requiring verbal interaction, and performing testing considerably more rapidly than is typically used for older children.

2. Early Detection and Prevention

A common approach to early detection and prevention of vision problems in preschool children is vision screening by pediatricians or other primary care physicians or lay screeners. Screenings for this population are less problematic than for infants and toddlers because some subjective testing is possible; however, screenings are less accurate for preschool children than for older children.[93-95] Reasonably accurate screening tests are available for the assessment of many visual functions. The problem with many vision screenings, however, is that they are limited in scope. They may detect only visual acuity problems and may fail to detect other important vision problems, leading to parents' or caregivers' false sense of security. A comprehensive eye examination at 3 years of age continues to be the most effective approach to prevention or early detection of eye and vision problems in the preschool child.

3. Examination Sequence

The pediatric eye and vision examination of the preschool child may include, but is not limited to, the following (see Appendix Figure 3):

a. Patient History

A comprehensive patient history for the preschool child may include:

- Nature of the presenting problem, including chief complaint
- Visual and ocular history
- General health history, including prenatal, perinatal, and postnatal history and review of systems
- Family eye and medical histories
- Developmental history of the child.

The collection of demographic data generally precedes the taking of the patient history. Having the parent(s) or caregiver(s) complete a questionnaire in advance of the examination facilitates obtaining the patient history.[43]

b. Visual Acuity

An assessment of visual acuity usually includes one of the following procedures:

- Lea Symbols chart
- Broken Wheel acuity cards
- HOTV test.

By 3 years of age, most children have the necessary behavioral and psychological development to allow subjective acuity testing. However, specially designed tests are still useful to limit the amount of verbal interaction needed. The 3-year-old child can easily match simple forms and responds well to learning through demonstration and imitation of tasks.[95] Visual acuity tests for this age group ideally involve a matching task or a forced-choice task, such as pointing to the correct response.

Use of the Broken Wheel acuity cards is appropriate for this age group. Very little verbal interaction is necessary, and the cards use a Landolt C target, considered the optimum type of test for visual acuity.[96] This test has the added advantage of established normative values.[97]

The Lea Symbols chart, which consists of four optotypes (circle, square, apple, house), also can be used with great success.[98] The child simply has to find a matching block or point to the shape that matches the target presented. This minimizes verbal interaction and makes the test very useful for children between 30 months and 5 years. The Lea Symbols chart is the first pediatric acuity test based on the logMAR scale, as recommended by the National Research Council Committee on Vision.[99] A study of the Lea Symbols and HOTV charts found that the two were comparable in 4- and 5-year-old children, but that in 3-year-olds, the Lea Symbols chart had better testability rates.[100] Only 8 percent of children were untestable with the Lea Symbols chart. Another study found that almost every child older than 30 months could be tested with the Lea Symbols chart.[101] The HOTV test can also be completed by many preschoolers.

c. Refraction

Measurement of refractive error may involve:

- Static retinoscopy
- Cycloplegic retinoscopy.

With two important modifications, standard static (distance, non-cycloplegic) retinoscopy can usually be performed in preschool children. A modern video projection system is a valuable means of controlling accommodation and fixation at 6 meters. Using a lens rack or loose lenses and fogging glasses rather than a phoropter enables the clinician to see the child's face and observe when the child loses fixation at 6 meters.

Cycloplegic retinoscopy is a valuable procedure for the first evaluation of preschoolers and when static retinoscopy yields unreliable results or professional judgment indicates otherwise. This procedure should also be performed when strabismus or significant refractive error is present.

Cyclopentolate (1%) is the cycloplegic agent of choice. Two drops should be instilled, one at a time, 5 minutes apart, in each eye.[71] The use of a spray bottle to administer the drug is also effective for this age group. Retinoscopy may be performed with a lens rack or loose lenses 20-30 minutes after instillation.[72]

d. Binocular Vision, Accommodation and Ocular Motility

The following procedures are useful for assessing binocular and accommodative function:

- Cover test
- Positive and negative fusional vergences (prism bar/step vergence testing)
- Near point of convergence (NPC)
- Stereopsis
- Monocular estimation method (MEM) retinoscopy
- Versions.

The cover test is the primary means of evaluating binocular vision in the preschool child. It should be performed in the primary position and, if necessary, in other cardinal positions of gaze to screen for noncomitant deviations. When a deviation is present, estimation of the magnitude or use of a prism bar enables more precise measurement. The results of the cover test can also be combined with version testing to rule out the presence of a noncomitant deviation.

If the cover test suggests a potentially significant heterophoria or intermittent strabismus, fusional vergence testing may be used to help determine whether treatment may be indicated. Fusional vergence can be assessed objectively, using the step vergence procedure.[103,104] To assess fusional vergence objectively, the clinician uses a hand-held prism bar and carefully observes the patient's eyes, looking for a loss of bifixation as the amount of prism is gradually increased.

The NPC is an excellent test to use with the preschool child because both the break and recovery measurements can be determined objectively. Instead of asking the child when he sees double, the clinician asks the

child to keep looking at the target as it is moved closer. The clinician carefully observes the child's eyes and determines when there is a loss of bifixation. The target is then moved away from the child until bifixation is regained. Using this procedure makes it easy to determine the NPC in a preschool child.

Stereopsis testing can generally be accomplished in preschool children, using commercially available stereopsis tests. To increase the ability to measure stereopsis, it is wise to use a matching procedure, in which the examiner constructs a set of figures that correspond to the figures in the stereopsis test booklet and simply asks the child to point to the picture he or she sees in the test booklet.

Objective accommodative testing can be performed in preschool children, using MEM retinoscopy. MEM retinoscopy is easy to perform with children of this age group and provides information about the accommodative response.

To assess extraocular muscle function and concomitancy, it is important to perform version testing in all cardinal positions of gaze, using a high-interest fixation target. When a problem is suspected, the cover test procedure can be used in the relevant position of gaze.

e. Ocular Health Assessment and Systemic Health Screening

An evaluation of ocular health may include:

- Evaluation of the ocular anterior segment and adnexa
- Evaluation of the ocular posterior segment
- Color vision testing
- Assessment of pupillary responses
- Visual field screening (confrontation).

With some modification, traditional testing used to assess ocular health in adults can be used in preschool children. Most preschool children will cooperate, allowing the use of the biomicroscope to evaluate the anterior segment. Pupillary dilation facilitates thorough evaluation of the posterior segment. With encouragement and assistance from the parent,

to help control fixation, binocular indirect ophthalmoscopy is often successful.

Color vision testing can generally be done with standard pseudoisochromatic plates or, preferably, with tests such as the Pease-Allen Color Test (PACT), the Mr. Color Test, or Color Vision Made Easy, which do not require the child to identify a number. All of these tests are easy to administer and have high testability rates in preschool children.[105-107]

Measurement of IOP is not a routine part of the eye and vision examination of preschool children, but pressure should be assessed when ocular signs and symptoms or risk factors for glaucoma exist. Hand-held applanation or noncontact tonometers are available for the measurement of IOP in this population. If it is not possible to assess IOP reliably under standard clinical conditions, testing under sedation or anesthesia may be appropriate.

Confrontation visual fields testing should be attempted with preschool children, when indicated, using the techniques described for infants and toddlers. When the results are equivocal or risk factors are present, the clinician should either retest the child or consult with or refer the child to a pediatric ophthalmologist or neurologist for appropriate testing.

f. Supplemental Testing

When the preschool child's history indicates a possible developmental lag or a learning problem, the optometrist may administer a developmental visual perceptual screening test to help diagnose and manage visual information-processing problems. The testing can help assess developmental level, detect visual perceptual dysfunction, and enable early identification of children at risk for the development of learning related vision problems.

The assessment of visual perceptual development may include:

- Denver Developmental Screening Test (DDST)
- Developmental Test of Visual Motor Integration (DTVMI)

Recommended for use in this age group,[108] the DDST was designed for use with children from birth through 6 years of age. Another test that can be used for screening children as young as 3 years is the DTVMI.[109] When visual perceptual problems are detected, consultation with an optometrist who has advanced clinical training or experience with this population should be considered. Referral for consultation with the child's pediatrician or other primary care physician or a child psychologist or psychiatrist should also be considered when problems in language and social development are detected.

g. Assessment and Diagnosis

Upon completing examination of the preschool-age child, the optometrist assesses and evaluates the data to establish the diagnosis and to formulate a management plan. In some cases, referral for consultation with or treatment by another optometrist, the patient's pediatrician or other primary care physician, or another health care provider may be indicated.

C. Examination of School-Age Children

1. General Considerations

This section of the Guideline describes the optometric examination of the school-age child. The discussion of examination components is presented in general terms and is not intended to be all inclusive. Professional judgment and individual patient history, symptoms, findings, and cooperation may have significant impact on the nature and course of the examination.

Some of the issues relating to infants, toddlers, and preschool children also apply to this population, particularly children younger than 8 years old. Age-appropriate examination and management strategies should be used. Although most of the examination procedures used with this age group are identical to those recommended for adults, age-appropriate modifications of instructions and targets often may be required.[43]

2. Early Detection and Prevention

The value of and need for school-based vision screening have been debated for decades. One concern is that the majority of school vision screenings test only visual acuity. Such testing primarily detects amblyopia and myopia, and only high degrees of astigmatism and hyperopia. Although detection of such disorders is certainly a worthwhile objective, screening for visual acuity alone generally detects only about 30 percent of children who would fail a professional eye examination.[110] Visual acuity screening often fails to detect those conditions that would be expected to affect learning. Parents or caregivers of children who pass vision screening may incorrectly assume that their children do not require further professional care.

3. Examination Sequence

The pediatric eye and vision examination of the school-age child may include, but is not limited to, the following (see Appendix Figure 4):

a. Patient History

A comprehensive patient history for the school-age child may include:

- Nature of the presenting problem, including chief complaint
- Visual and ocular history
- General health history, including prenatal, perinatal, and postnatal history and review of systems
- Family eye and medical histories
- Developmental history of the child
- School performance history.

The collection of demographic data generally precedes taking the patient history. Having the parent(s) or caregiver(s) fill out a questionnaire facilitates obtaining the patient history. Because of the relationship between vision and learning, special attention needs to be paid to the child's school performance. When a child is not performing up to potential, the optometrist should probe for signs and symptoms

suggestive of a learning related vision problem.[111*2] Questions can be designed to define the specific nature of the learning problem and to distinguish disorders of visual efficiency from a visual perceptual or nonvisual disorder.[112]

b. Visual Acuity

Visual acuity may be assessed with the Snellen acuity chart (modified for children 6-8 years of age). A recommended modification is the isolation of one line, or even one-half line of letters, rather than projection of a full chart.

c. Refraction

Measurement of refractive error may involve use of the following procedures:

- Static (distance) retinoscopy
- Cycloplegic retinoscopy
- Subjective refraction.

For children over the age of 8, the clinician can usually use traditional assessment procedures to measure refractive error. For patients below age 8, static (distance) retinoscopy may be performed without a phoroptor, using a lens rack or loose lenses and fogging glasses. This procedure allows the practitioner to move with the child and to observe whether the child is fixating properly. Cycloplegic refraction may be necessary in such conditions as strabismus, amblyopia, or significant hyperopia.

d. Binocular Vision, Accommodation, and Ocular Motility

Evaluation of binocular and accommodative function and ocular motility may include the following procedures:

[2] Refer to the Optometric Clinical Practice Guideline for Care of the Patient with Learning Related Vision Problems.

- Cover test
- Near point of convergence (NPC)
- Positive and negative fusional vergences
- Accommodative amplitude and facility
- Monocular estimation method (MEM) retinoscopy
- Stereopsis
- Versions.

Other than refractive errors, the most prevalent vision conditions in children fall into the category of accommodative and binocular vision anomalies.[41] These conditions may interfere with school performance, causing a number of symptoms, including eyestrain, blurred vision, double vision, loss of place, skipped lines, word movement on the page, inability to sustain attention when reading, and decreased reading comprehension over time.[109,113-119] Careful evaluation of these conditions in the school-age population is critical.

Evaluation of accommodation and fusional vergence should involve assessment of both the amplitude and the facility of the response. For accommodation, the evaluation may include assessment of accommodative amplitude, accommodative facility using +2.00/-2.00 D lenses, and accommodative response using MEM retinoscopy.

Binocular evaluation should include the cover test and tests of accommodative convergence/accommodation (AC/A) ratio, fusional vergence amplitude with either the Risley prisms or the prism bar, vergence facility, and stereopsis, using a random dot stereopsis test. Additionally, negative relative accommodation (NRA) and positive relative accommodation (PRA) tests may contribute to an understanding of both accommodation and binocular status. In analyzing these tests, it is important to examine all data and group findings, rather than depending on any one isolated finding, to arrive at a diagnosis.[120]

Versions can be performed to rule out a noncomitant deviation. Qualitative examination of eye movements involves three distinct steps: assessment of stability of fixation, saccadic function, and pursuit function. Subjective techniques involving observation of the patient's

fixation and eye movements have been developed, along with rating scales, to probe these three areas.[121]

e. Ocular Health Assessment and Systemic Health Screening

An assessment of ocular health may include:

- Evaluation of the ocular anterior segment and adnexa
- Evaluation of the ocular posterior segment
- Measurement of intraocular pressure
- Color vision testing
- Assessment of pupillary responses
- Visual field screening (confrontation).

Traditional testing procedures utilized for the evaluation of ocular health in adults can be used with school-age children. Most will cooperate and allow use of the biomicroscope to evaluate the anterior segment and binocular indirect ophthalmoscopy to evaluate the posterior segment. Pupillary dilation allows for thorough evaluation of the posterior segment and may be repeated as needed at subsequent visits.[122]

The measurement of IOP in school-age children is generally successful with either applanation or noncontact tonometry. Although the prevalence of glaucoma is low in this population, a baseline measurement at this age is valuable. Tonometry may be repeated as needed at subsequent visits.

If color vision testing was not administered when a preschool child, it should be performed at this age. As children enter school, 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.[123] Moreover, color vision deficiency may indicate an ocular health problem.[124]
Evaluation of visual fields can be performed in school-age children using confrontation visual field screening.

f. Supplemental Testing

Visual information processing function can be evaluated using tests that probe the following areas:

- Directionality
- Visual motor integration.

This testing is not routine; however, when the patient history indicates a possible developmental lag or a history of learning problems, a visual perceptual screening is warranted.[125] Two tests available for probing these areas are the Gardner Reversal Frequency Test–Recognition subtest (directionality) and the Developmental Test of Visual Motor Integration. When a visual information processing problem is detected, consultation with an optometrist who has advanced clinical training or experience in this area should be considered. Referral for consultation with the child's pediatrician or other primary care physician, the school system, a child psychologist or psychiatrist, or the state or local Department of Special Education should be considered when problems in other developmental areas such as behavior, language, or social development are detected, or when a full psychoeducational evaluation is indicated.

g. Assessment and Diagnosis

Upon completion of the examination, the optometrist should assess and evaluate the data to establish a diagnosis and to formulate a management plan. In some cases, referral for consultation with or treatment by another optometrist, the patient's pediatrician or other primary care physician, or another health care provider may be indicated.

D. Management of Children

1. Patient Education

Discussion and communication with the parents or caregivers and the child should occur at the end of the eye examination to review test findings. The optometrist's primary responsibility in this area is educating parents or caregivers about any eye or vision disorders and vision care. Many parents and caregivers believe the screening performed by the child's pediatrician or other primary care physician or school nurse is sufficient to rule out all significant visual disorders. However, these screenings are limited and were not intended to replace a comprehensive eye examination (see Table 1).

The importance of adhering to an eye and vision examination schedule should be emphasized from a preventive standpoint as well. Early detection and preventive care can help avoid, or minimize, the consequences of disorders such as amblyopia and strabismus.

The optometrist can also play an important role by educating parents/caregivers and children about eye safety, particularly regarding sports-related eye safety. Sports and recreational activities accounted for nearly 40,000 of the eye injuries reported in 1991. Baseball injuries were the most frequent cause of eye injuries among children 5-14 years of age.[126] A spectacle lens material equivalent or superior in impact resistance to that of 2mm polycarbonate or Trivex™ material is recommended for use with children, except when such lenses will not fulfill the visual requirements of the patient. For those cases in which protective lens materials are not used, the optometrist should obtain informed consent from parents and/or caregivers.

Optometrists should educate parents or caregivers about the importance of early, preventive eye care, including examinations at the age of 6 months, at age 3, before entering first grade, and periodically during the school years. The extent to which a child is at risk for the development of eye and vision problems determines the appropriate re-evaluation schedule. Individuals with ocular signs and symptoms require prompt examination. Furthermore, the presence of certain risk factors may

necessitate more frequent examinations, based on professional judgment (see Table 4).

Table 4
Recommended Eye Examination Frequency for the Pediatric Patient

	Examination Interval	
Patient Age	**Asymptomatic/ risk-free**	**At-risk**
Birth to 24 months	At 6 months of age	At 6 months of age or as recommended
2 to 5 years	At 3 years of age	At 3 years of age or as recommended
6 to 18 years	Before first grade and every 2 years thereafter	Annually or as recommended

2. Coordination, Frequency, and Extent of Care

The developing visual system is considered most susceptible to interference during the first few years of life.[51,127-129] In the child of 6 months, vision has assumed the position of dominant sense, and it will form the basis of later perceptual, cognitive, and social development.[130] Moreover, in the child of this age, vision has rapidly developed in most crucial areas, including visual acuity, accommodation, and stereopsis.[11-17] Interference during this critical phase of development may be deleterious. For instance, abnormalities present at birth and shortly thereafter, including opacities of the ocular media (e.g., congenital cataract) and early-onset strabismus, may have profound effects on the developing visual system. Thus, the efforts of the child's pediatrician or other primary care physician are vital in the detection of ocular abnormalities that may require referral for an eye examination and treatment.

The child's first eye and vision examination should be scheduled at 6 months of age (or sooner if signs or symptoms warrant). When no abnormalities are detected at this age, the next examination should be scheduled at age 3.

The child considered at risk for the development of eye and vision problems may need additional testing or more frequent re-evaluation. Factors placing an infant, toddler, or child at significant risk for visual impairment include:

- Prematurity, low birth weight, prolonged supplemental oxygen, or grade III or IV intraventricular hemorrhage
- Family history of retinoblastoma, congenital cataracts, or metabolic or genetic disease
- Infection of mother during pregnancy (e.g., rubella, toxoplasmosis, venereal disease, herpes, cytomegalovirus, or human immunodeficiency virus)
- Difficult or assisted labor, which may be associated with fetal distress or low Apgar scores
- High refractive error
- Strabismus
- Anisometropia
- Known or suspected central nervous system dysfunction evidenced by developmental delay, cerebral palsy, dysmorphic features, seizures, or hydrocephalus.

Because of the importance of vision in learning, early detection and treatment of vision problems in school-age children are major public health goals as delineated in Healthy People 2010.[9] An estimated 17-25 percent of school-age children have vision problems,[10] many of which may interfere with the children's abilities to reach their potential in school. It is clear that all school-age children should have comprehensive eye and vision examinations, before entering the first grade and periodically thereafter. Some children may require more frequent care, depending on the nature of any diagnosed eye or vision disorder.

CONCLUSION

Children account for a large and growing percentage of the population of the United States. Studies have demonstrated that the prevalence of eye and vision disorders is substantial in this group. Research also 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 disorders such as amblyopia and strabismus are undetected, the long-term consequences can be serious in terms of quality of life, comfort, appearance, and career opportunities. In addition, the cost of providing appropriate treatment for longstanding eye and vision disorders may be significantly higher than the cost of detecting and treating these problems early in life.

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IV. APPENDIX

Figure l
Pediatric Eye and Vision Examination:
A Brief Flowchart

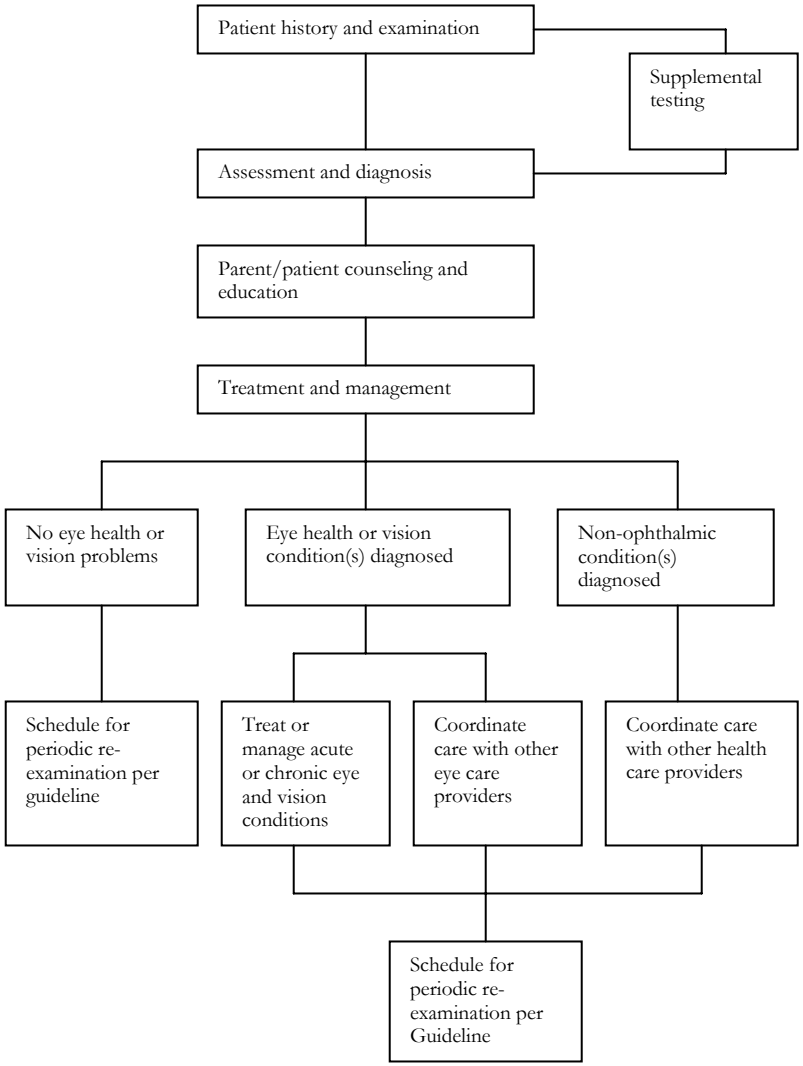

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Figure 2
Potential Components of the Eye and Vision Examination for Infants and Toddlers

A. Patient History
1. Nature 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. Family eye and medical histories
5. Developmental history of the child

B. Visual Acuity
1. Fixation preference tests
2. Preferential looking visual acuity test

C. Refraction
1. Cycloplegic retinoscopy
2. Near retinoscopy

D. Binocular Vision and Ocular Motility
1. Cover test
2. Hirschberg test
3. Krimsky test
4. Brückner test
5. Versions
6. Near point of convergence

E. Ocular Health Assessment and Systemic Health Screening
1. Evaluation of the ocular anterior segment and adnexa
2. Evaluation of the ocular posterior segment
3. Assessment of pupillary responses
4. Visual field screening (confrontation)

F. Supplemental Testing
1. Electrodiagnostic testing

Figure 3
Potential Components of the Eye and Vision Examination for Preschool Children

A. Patient History
1. Nature 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. Family eye and medical histories
5. Developmental history of the child

B. Visual Acuity
1. Lea Symbols chart
2. Broken Wheel acuity cards
3. HOTV test

C. Refraction
1. Static retinoscopy
2. Cycloplegic retinoscopy

D. Binocular Vision, Accommodation, and Ocular Motility
1. Cover test
2. Positive and negative fusional vergences (prism bar/step vergence testing)
3. Near point of convergence
4. Stereopsis
5. Monocular estimation method (MEM) retinoscopy
6. Versions

E. Ocular Health Assessment and Systemic Health Screening
1. Evaluation of the ocular anterior segment and adnexa
2. Evaluation of the ocular posterior segment
3. Color vision testing
4. Assessment of pupillary responses
5. Visual field screening (confrontation)

F. Supplemental Testing
1. Denver Developmental Screening Test (DDST)
2. Developmental Test of Visual Motor Integration (DTVMI)

Figure 4
Potential Components of the Eye and Vision Examination for School-Age Children

A. Patient History
1. Nature 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. Family eye and medical histories
5. Developmental history of the child
6. School performance history

B. Visual Acuity
1. Snellen acuity chart (with modification for children 6-8 years of age)

C. Refraction
1. Static retinoscopy
2. Subjective refraction

D. Binocular Vision, Accommodation, and Ocular Motility
1. Cover test
2. Near point of convergence
3. Positive and negative fusional vergences
4. Accommodative amplitude and facility
5. Monocular estimation method (MEM) retinoscopy
6. Stereopsis
7. Versions

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

F. Supplemental Testing
1. Directionality
2. Visual motor integration

Abbreviations of Commonly Used Terms

AC/A	-	Accommodative convergence/accommodation ratio
D	-	Diopter
DDST	-	Denver Developmental Screening Test
DTVMI	-	Developmental Test of Visual Motor Integration
IOP	-	Intraocular pressure
MEM	-	Monocular estimation method
NPC	-	Near point of convergence
NRA	-	Negative relative accommodation
PACT	-	Pease-Allen color test
PD	-	Prism diopter
PRA	-	Positive relative accommodation
SBS	-	Shaken baby syndrome

Glossary

Accommodation The ability of an eye to focus clearly on objects at various distances, or through various lens powers, resulting from changes in shape of the crystalline lens.

Adnexa The accessory structures of the eye, including the eyelids, lacrimal apparatus, and the extraocular muscles.

Anterior ocular segment The part of the eye including and anterior to the crystalline lens (i.e., cornea, anterior chamber, iris, ciliary body).

Color vision The ability to perceive differences in color.

Cover test A clinical test to determine the ocular alignment of the eyes and measure the magnitude of the angle of deviation of the visual axes.

Directionality The ability to understand and identify right and left directions in external visual space.

Intraocular pressure (IOP) The pressure within the eye relative to the constant formation and drainage of aqueous humor.

Near point of convergence (NPC) The maximal extent the eyes can be converged, using tonic, accommodative, fusional, and proximal convergence.

Negative relative accommodation (NRA) A measure of the ability to relax accommodation while maintaining binocular vision at a fixed distance, usually 40 cm. Measurement is made with plus-lens additions until the patient reports the first sustained blurring of the target.

Positive relative accommodation (PRA) A measure of the ability to stimulate accommodation while maintaining binocular vision at a fixed distance, usually 40 cm. Measurement is made with minus-lens additions until the patient reports the first sustained blurring of the target.

Posterior ocular segment The part of the eye located posterior to the crystalline lens (i.e., vitreous, choroid, retina, optic nerve).

Pupillary response The response of the pupils of the eyes to stimulation by light or accommodation.

Refraction Clinically, the determination of the refractive errors of an eye, or eyes (e.g., myopia, hyperopia, astigmatism, anisometropia).

Refractive status (refractive error) The degree to which images received by the eyes are not focused on the retina (e.g., myopia, hyperopia, astigmatism).

Stereopsis Binocular visual perception of three-dimensional space, based on retinal disparity. Clinically referred to as depth perception.

Suppression Under binocular viewing conditions, the inability to perceive all or part of objects in the field of vision of one eye, attributed to cortical inhibition.

Vergence Disjunctive movements of the eyes in which the visual axes move toward each other with convergence or away from each other with divergence.

Version Conjugate movement in which the two eyes move in the same direction.

Visual acuity The clearness of vision that depends on the sharpness of the retinal image and the integrity of the retina and visual pathway. It is expressed as the angle subtended at the anterior focal point of the eye by the detail of the letter or symbol recognized.

Visual field The area or extent of space visible to an eye in a given position.

Visual motor integration The ability to integrate visual information with fine motor movements.

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