



# **Clinical Practice Guide**

## **Paediatric Eye Health and Vision Care**

August 2016

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*Optometry Australia has developed this clinical practice guide in consultation with an expert working group comprised of 6 experienced practitioners who work extensively in the area of paediatric optometry.*

#### **Working Group**

Steve Leslie

Christine Nearchou

Rod Baker

Timothy Martin

Liz Jackson

Marissa Megaloconomos

Simon Hanna - Chair



## CLINICAL PRACTICE GUIDE

### Provision of Paediatric

### Eye Health and Vision Care Examination

#### Executive Summary

- Optometrists are ideally placed to provide appropriate eye health care through effective assessment, diagnoses and treatment of a range of paediatric eye health and vision conditions.
- The 2008 Australian Institute of Health and Welfare report on Eye health among Australian children states that in 2004, 3.7% of children reported suffering from hyperopia and 3.5% from myopia<sup>1</sup>.
- The Australian Bureau of Statistics National Health Survey found in 2004-05 that approximately 16% of 10-14 year olds wore lenses (glasses or contact lenses) to correct sight<sup>2</sup>.
- Optometrists play a pivotal role in preventative eye health, screening for common eye diseases and disorders and referral upon indication.
- Whilst careful consideration of the child's age and development is required in determining the appropriate testing protocol, Optometry Australia's clinical practice guide outline the standard testing protocol which includes:
  - **Patient History**
  - **Visual Acuity**
  - **Refraction**
  - **Binocular Vision Testing**
  - **Stereopsis**
  - **Colour Vision Assessment**
  - **Ocular Health Assessment**
- Referral to a more experienced optometric colleague for vision therapy or other clinical intervention including strabismus and/or amblyopia treatment, may be required.
- Referral to an ophthalmologist for surgical or other specialist management may be indicated in some circumstances.
- Medicare item 10910 may be billed once every 3 years for comprehensive eye examinations over 15 mins duration or longer and where appropriate, item 10943 should be billed for additional testing to confirm diagnosis of, or establish a treatment regime for a significant binocular vision or accommodative/vergence disorder.

*This clinical practice guide provide recommendations to optometrists on the assessment and monitoring of paediatric patients for optometric assessment. They are not intended to be prescriptive and optometrists are required to exercise their clinical judgement in provision of any clinical care. They should not be used as a substitute for statutory responsibilities and optometrists must ensure that they comply with State and Federal Laws.*

This document aims to establish a guide on the provision of eye care to infants and children.

Optometrists, in their capacity as primary health care providers, play a pivotal role in the provision of eye care services to children in Australia. This role includes the detection and correction of refractive errors, such as myopia and hyperopia and the early detection and prevention of vision loss associated with eye disease.

In a 2002 study, in an investigation of the incidence of functional vision problems in a population of primary school-aged children, 25% children presented with an ocular condition.<sup>3</sup> In the last decade, this number may have increased with changing environmental and lifestyle factors.<sup>4</sup> For example, prevalence of myopia in children is rising worldwide with urbanisation,<sup>5</sup> less time spent outdoors,<sup>6</sup> increasing usage of screen-based technology, and increasing levels of near vision tasks being undertaken by young children.<sup>7</sup> The impact of such factors on the eyes and visual system is not yet fully understood.

Optometry Australia believes it is important that all optometrists are confident and competent in managing paediatric patients and identifying when an appropriate referral is required. This includes appropriate communication, assessment, diagnosis and management of paediatric eye conditions so that they are able to provide evidence-based management and advice.

Whilst some children present with their parents\* for a routine eye examination prior to or after starting primary school, others are referred to an optometrist through existing care pathways via other medical, health or educational providers.

Given the unique characteristics of examination structure, assessment, diagnosis and management of paediatric eye conditions, this document will focus on providing a framework for the assessment of children who attend for a full eye health and vision examination. Where appropriate the examination should incorporate potential **treatment and management** plans or when indicated, recommend referral to another optometrist or health care practitioner (most commonly paediatric ophthalmologist).

This practice guide is also intended to assist optometrists in developing an **appropriate schedule** for eye examinations for children, selecting **appropriate tests** for individual age groups and describing clinical tips to support **effective** eye examinations in children.

In some instances, infants, toddlers or older children will present for an eye examination that may require a **referral**. These may include:

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\* Parents/Guardians – Throughout this document, all references to parents may encompass legal guardians or other legally recognised carers.

- **Binocular vision disorders**
- **Strabismus**
- **Amblyopia**
- **Learning difficulties**
- **Behavioural concerns**
- **Developmental delays**

Appropriate referral and a detailed report to an experienced clinician may be required if any ocular or developmental issues are identified. For those identified with binocular vision disorders, learning difficulties or behavioural concerns, optometrists who provide more complex investigation and diagnosis, and Vision Therapy and/or Vision Processing Assessments can assist in the management and provision of appropriate care.

Paediatric patients have been divided into 3 aged-based categories in order to make a distinction between the different examination procedures and management and review schedules that are most appropriate to each age group. The three categories are:

- **Infants & Toddlers (Birth to 2 years 11 months)**
- **Pre-School and early primary school aged children (3 years to 6 years 11 months)**
- **Older primary school aged children (7 – 14 years)**

The following will not be included in this practice guide as these are major areas of paediatric treatment, considered best addressed through specific guidelines:

- **Treatment of Binocular Vision disorders in children**
- **Treatment of Strabismus and Amblyopia in children**
- **Treatment of Refractive error in children**
- **Treatment of Ocular Disease in children**

*Note: The testing protocol described below for each group is based on expected age based development. Many children can vary significantly from expected age norms and it is important that the testing procedures be carefully selected and based on the child's developmental age and specific capability.*

**Table 1 (see appendix)** outlines the potential components of a comprehensive vision and eye health examination for different age categories. It is recommended that each consultation is tailored to suit the needs of the individual child. Factors to consider include their ability to comprehend and undertake tests as well as clinical need based on presentation and symptoms.

**SECTION A: Clinical Practice Guide on the vision and eye health assessment and management of Infants and Toddlers**

**Paediatric Eye Examination of Infants & Toddlers (Birth to 2 years & 11 months).**

**Reason for Visit**

Children presenting to an optometrist in this age group will generally fall into four categories:

Reasons for visit	
Routine Eye Examination	A parent may decide to bring their child in for routine eye examination in the absence of signs or symptoms
Screening indicates further testing	Referral from paediatric screening service, either in the first few months after birth or in the process of a scheduled general health visit
Referral from other professions	Referral or recommendation from health care practitioners including general practitioners, paediatricians or other medical specialists
Parental observation	A parent notices signs of potential eye health or vision problem, which may include eye-rubbing, squinting, clumsiness or a significant turn to one or both eyes
Family history	A parent may decide to bring their child in for a routine examination due to an existing family ocular or general health history.

**Clinical Pearls:** The components of an examination outlined below are not exhaustive and may be modified or supplemented as necessary. Infants and toddlers perform best when they are alert and rested. It assists the examination when children are fed and usually after their nap to maximise cooperation which is often difficult in this age group.

## Examination Sequence

### a. Patient History

A comprehensive history for this age group incorporates obtaining information from the parent or guardian as well as taking into account any information from a referral. Essential areas to address include:

- **Chief complaint:** Identification of presenting complaint (if applicable).
- **Visual and previous ocular history:** including patching, surgery, infections or injuries.
- **General health history:** including relevant prenatal, perinatal and postnatal history e.g. complications associated with childbirth and whether the child is full term or premature.
- **Family ocular and medical history:** including eye conditions of siblings.
- **Developmental history:** attainment of expected developmental milestones.
- **Behaviour:** Questioning around changes to behaviour and approach to common tasks.

### b. Visual Acuity

Habitual vision may be measured **monocularly** and/or **binocularly** in pre-verbal children. At this age significant deviation from normative visual acuity may indicate a potential problem and an accurate measure of visual acuity assists in confirming/ruling out the presence of ocular conditions.

**Clinical Pearls:** Measuring visual acuity subjectively in this age group can be challenging. A number of objective methods can be performed by optometrists to determine visual acuity. *Table 3 (see appendix)* shows the approximate visual acuity expected for each age group. Whilst there may be slight variations to this normative data, any major deviation requires further investigation to identify a possible cause. In particular, differences in acuity between the two eyes need further investigation.<sup>8</sup> The practitioner should consider one of these *objective* methods when measuring visual acuity:

- **Preferential Looking Tests**
  - **Teller acuity cards**
  - **Lea Paddles.**
  - **Cardiff acuity cards**
  - **Keeler Acuity cards**
- **Fixation Preference Test** – has reasonable validity in the presence of strabismus. In the absence of strabismus, sensitivity and specificity are reduced.<sup>9</sup>
- **Other Tests**
  - **General qualitative observation**
    - Fix and follow
    - Dolls eye reflex
  - **Optokinetic nystagmus drum**
  - **Aversion to occlusion** of one eye
  - **Patti Pics/ Lea shapes:** Patients between 2 ½ years (advanced) & 3 ½ years can typically do Patti Pics/ Lea shapes (matching task when younger)

## Referral

In the event that clinical evaluation of visual acuity is unobtainable due to lack of cooperation or significantly poor acuity, consultation with a paediatric optometrist or ophthalmologist with paediatric experience may be warranted if a return visit or attempt at appropriate amblyopia therapy is not undertaken.

### c. Refraction

Conventional subjective refraction is largely ineffective in this age group due to short attention spans, poor fixation, poor cognitive and linguistic ability or fluctuations in accommodation. The optometrist must use objective measures with which to quantify an infant or toddler's refractive error. Common techniques include:

- **Static (Dry) Retinoscopy**

If age-expected visual acuities, stereopsis and alignment of eyes can be measured accurately, dry retinoscopy may be a useful technique to measure refractive error. This form of objective testing can be used if a child's attention can be engaged at the end of the consulting room by appropriate distance targets, possibly with the assistance of a parent. This may include a video or poster with appropriate details to keep the child's attention. If the child is verbal, asking questions about the target will help control fixation. Static retinoscopy should be considered as the initial technique prior to considering other methods requiring cycloplegic drops. Using a lens rack or loose lenses rather than a phoropter removes the barrier between clinician and child, enhancing communication and observation of the child. It also reduces the stimulus to proximal accommodation.

- **Cycloplegic Retinoscopy**

#### Notes of the use of Cycloplegic drops

Cyclopentolate Hydrochloride is a cycloplegic agent that may be used when performing retinoscopy in this age group to control accommodation. It is also important to consider the use of cycloplegia if there is a suspicion of or in the presence of strabismus and/or amblyopia or where this is a large refractive error. Cycloplegia will aid in obtaining an accurate refraction result.

#### **Clinical Pearls**

- For children less than 6 months of age a concentration of 0.5% Cyclopentolate Hydrochloride is recommended while 1% is recommended for children older than 6 months.<sup>10</sup>
- **It is particularly important that the lowest concentration that yields desired cycloplegia is used in children with Down syndrome, cerebral palsy and other CNS disorders in whom there may be an increased reaction to cycloplegic agents.**<sup>11</sup> In these cases, Tropicamide (1%) may be used as the dilating agent.
- Retinoscopy should be performed 30 - 45 minutes after administration of eye drops.<sup>10</sup> An appropriate distance target should be used to control fixation and any remaining accommodation.



- **Near Retinoscopy/Mohindra Dark Retinoscopy:**

This is generally conducted by turning off all lights in the consulting room and encouraging the child to focus on the retinoscope light, without the use of cycloplegic drops. A working distance of (approximately) 50cm is used. Loose trial lenses are used to neutralise the retinoscopy reflex and 1.25D subtracted from the result to account for accommodation to target light. (It has been suggested subtracting only 0.75D for children <2 years of age can improve accuracy).<sup>12,13</sup>

#### Expected refractive error values

*Table 6 (see appendix)* shows the approximate refractive error in a study conducted on a large sample of pre-school children aged between 30-72 months.<sup>14</sup> Whilst there may be slight variations to this normative data, any major deviation requires further investigation to identify a possible cause. In particular, major differences in acuity or refractive error between the two eyes need further investigation.

#### d. Binocular Vision

In infants and children less than 12 months old, the following tests may be useful in determining binocular vision status:

- **Cover test** (distance and near)
- **Hirschberg test**
- **Krimsky test**
- **Bruckner test** (whilst limited in sensitivity<sup>15</sup>, is useful for looking at opacities and differences in reflexes between eyes)
- **Ocular Excursions**
- **Near Point of Convergence**

Given the likely inattention and poor fixation of a child at this age, a cover test may be difficult to conduct. In this event, a **Hirschberg** test can confirm the presence of a strabismus and the **Krimsky** test can quantify the magnitude of the deviation using prisms.

The **Bruckner** test, where the presence of a brighter reflex on the turned eye is observed, can also be a useful tool in confirming strabismus in this age group. This test is generally conducted at 50cm with +2D in ophthalmoscope to account for working distance. If a positive Bruckner test is observed, the deviation can be quantified using the Krimsky technique.

A “positive” **Brucker test** may be indicative of strabismus and is characterised by:

- Asymmetry of the red reflex;
- Unequal pupil size; and
- Displacement of the central light reflex.

Extraocular muscles movements can also be assessed using either a pen torch or appropriate fixation target. An accommodative target can be used to assess near point of convergence.

## Referral

If a binocular vision disorder or limitation of ocular motility is suspected, referral to an experienced paediatric optometrist or paediatric ophthalmologist may be warranted.

## Stereopsis

Examples of suitable clinical tests to assess the child's stereopsis include:<sup>16</sup>

- **Titmus Fly**
- **Randot Stereo**
- **Lang I and II**<sup>17</sup>
- **Frisby Test**
- **TNO stereo test**
- **Preschool Assessment of Stereopsis with a Smile test**<sup>18</sup>
- **Randot Preschool Stereoacuity Test.**<sup>19</sup>

*Tables 4 and 5 (see appendix)* shows the approximate stereoacuity expected for each age group.<sup>20</sup> Whilst there may be slight variations to this normative data, any major deviation requires further investigation to identify a possible cause.

## Suppression

Suppression testing is important in diagnosing or eliminating conditions of binocular vision disorders including strabismus, amblyopia, convergence insufficiency and aniseikonia. During the eye examination, the presence of suppression at various distances and the size and location of the suppression scotoma may be assessed using the **Worth 4 dot test.**<sup>21</sup> There may be variable reliability in this age group, with some advanced children being able to do this test.

## Colour Vision

Colour vision testing is essential in determining if a child is colour vision deficient. Most frequently colour vision deficiency is congenital and cannot be treated however awareness and classifications may enhance learning and educational outcomes. Further, early detection, classification and discussion with parents is vital to ensure understanding of any occupational restrictions that might be relevant once the child reaches working age. Colour vision deficiency may also be acquired and indicate an ocular health problem which is why it is recommended that all children are tested at a routine paediatric examination. If a colour vision test is attempted but a result cannot be obtained, the test should be repeated when the child is older. For this age group, the most appropriate test is **Color Vision Testing Made Easy.**<sup>22</sup>

## e. Ocular Health Assessment

Ocular health assessment for an infant or newborn may include:

- Gross inspection of the external features, including lid anatomy
- Assessment of Pupillary Responses
- Assessment of the anterior segment
- Assessment of the posterior segment

Whilst this area of a paediatric eye examination may pose difficulty, it is essential that major eye disease is excluded during examination. Standard procedures including tonometry, slit lamp assessment and binocular indirect ophthalmoscopy are commonly more difficult in this age group in instances where a child cannot follow instructions or cooperate for the entire duration of the assessment.

Pupillary response can be assessed using an ophthalmoscope or hand held trans-illuminator. Direct, consensual and afferent pupil functions should be evaluated. Leukocoria, potentially signifying the presence of a retinoblastoma, can also be screened for and diagnosed in young children by detecting an abnormal white reflex from the retina.<sup>23</sup> A hand held biomicroscope can then be used to evaluate the anterior ocular segment. It can often assist the examination if the infant or toddler is seated in a parent or guardian's lap.

Examination of posterior ocular media generally requires pupillary dilation where clinically indicated. This may be in the presence of a chronic disease or significant sight threatening symptoms or signs. Numerous population studies recommend the drug and dosage for safe pupil dilation to be one drop of Tropicamide (0.5% - 1%)<sup>24,25</sup>. Once the pupils are dilated, direct and indirect ophthalmoscopy can be conducted to assess the health of the posterior segment. If cycloplegic retinoscopy has been performed, ocular health assessment can be done in conjunction.

The absence of adequate retinal examination together with other concerns in such children should be considered a reason for referral for examination under general anaesthesia.

### **IOP in infants where clinically indicated**

Although extremely rare in infants, glaucoma may present in this age group.<sup>26</sup> Family history and existing ocular pathology in infants remain the strongest risk factors for congenital or infantile glaucoma.<sup>27</sup> In the event that intraocular pressures need to be measured, handheld applanation tonometry, non-contact tonometry or rebound tonometry may be used however it is important to note that the accuracy of these results can often be unreliable if there is limited concentration and/or cooperation from the child.

## f. Evaluation, Diagnosis & Management

It is important upon completion of the eye examination that all aspects are analysed for results that lie outside what is considered the normative data. This will help the optometrist to arrive at a diagnosis and establish a management plan. A clear and concise explanation to the parent must ensue, followed by an outline of any treatment or management protocol and expected review periods. In instances where the assessment or management is beyond the scope and experience of the optometrist, referral for consultation or treatment by another optometrist, or other physician (e.g. paediatrician, ophthalmologist, general practitioner) is recommended.

## **SECTION B: Clinical Practice Guide on the vision and eye health assessment and management of Pre-School children**

### **Paediatric Eye Examination of Pre-School children (Age 3 years – 6 years & 11 months).**

#### **Reason for Visit**

The components of an examination outlined below are not exhaustive and may be modified or supplemented as necessary. Whilst the vast majority of children in this age group can communicate verbally, it is important a parent or guardian accompany the child in the consulting room. In addition to legal considerations, this often helps in facilitating a response from children and providing greater comfort for the child in an unfamiliar environment. Often, having siblings in the consultation room may cause an unnecessary distraction and this should be avoided and sensitively discussed with parents as necessary.

The presentation of this age group to optometrists will generally fall into five categories:

<b>Reasons for visit</b>	
<b>Routine Eye Examination</b>	A parent may decide to bring their child in for routine eye examination in the absence of signs or symptoms
<b>Screening indicates further testing</b>	Referral by the paediatric screening service at a scheduled visit
<b>Referral from other health care professional</b>	Referral or recommendation by a health care practitioner including general practitioner, paediatrician or other medical specialist
<b>Parental observation</b>	A parent or carer notices particular behaviours that concern them, which may include eye-rubbing, squinting, clumsiness or a significant turn to one or both eyes
<b>Family history</b>	A parent may decide to bring their child in for a routine examination or because a sibling or other relation has an existing eye problem
<b>Referral from other professional</b>	Referral by a cognitive or educational specialist (e.g. teacher or psychologist) who has noticed particular signs including squinting, difficulty seeing the board or missing lines whilst reading.

## Examination Sequence

### a. Patient History

A comprehensive history for this age group incorporates obtaining information from the child where appropriate, the parent or guardian and any referral. Areas that need to be covered include:

- **Chief complaint:** Identification of presenting complaint (if applicable).
- **Visual and previous ocular history:** including patching, surgery, infections or injuries.
- **General health history:** including relevant prenatal, perinatal and postnatal history e.g. complications associated with childbirth.
- **Family ocular and medical history:** including eye conditions of siblings and other relations.
- **Developmental history:** attainment of expected developmental milestones.
- **Behaviour:** Questioning around changes to behaviour and approach to common tasks.

### b. Visual Acuity

Both monocular and binocular measurements of visual acuity in this age group are essential for early detection of any refractive error or amblyopia. Whilst “normal” acuity of 6/6 is not expected for the majority of this age group, any considerable deviation from expected values may indicate a problem (Table 3 – appendix).<sup>8</sup> If a child presents with correction, visual acuities should be measured both monocularly as well as binocularly, aided and unaided. Techniques for measuring acuity can include:

- **Patti Pics or Lea Chart** at 3m or 6m
- **Snellen chart** at 6m - Multiple line presentation or crowding bars should be used to increase sensitivity of detection of amblyopia. If this cannot be done with young children then single line presentations with crowding bars can also be considered.
- **Broken Wheel Test** is a good alternative if the tests above cannot be conducted.

### c. Refraction

Conventional subjective refraction is considered difficult in this age group due to short attention span and limitations in understanding however can be performed depending upon the child. The optometrist should employ objective measures with which to quantify the child’s refractive error. Two of the most common techniques include:

- **Static (Dry) Retinoscopy**

Retinoscopy without the use of cycloplegic drops can be performed whilst controlling accommodation. Using a lens rack or loose lenses rather than a phoropter removes the barrier between clinician and child, enhancing communication and observation of the child. It also reduces the stimulus to proximal accommodation. It is important to have the child focussing on an appropriate target to control accommodation such as a video or poster to obtain an accurate measurement. Static retinoscopy should be considered as the initial technique prior to considering other methods requiring cycloplegic drops.

- **Cycloplegic Retinoscopy**

Notes of the use of Cycloplegic drops

The use of cycloplegia allows for the control of accommodation and is still appropriate if an objective measure cannot be obtained with dry retinoscopy. It is also important to consider the use of cycloplegia if there is a suspicion of or in the presence of strabismus and/or amblyopia. Cycloplegia will aid in obtaining an accurate refraction result.

**Clinical Pearls**

- The common dosage for this age group is one drop of 1% Cyclopentolate Hydrochloride in each eye.<sup>10</sup> Retinoscopy may be performed 45 minutes after administration of eye drops.
- **It is important that the lowest concentration that yields desired cycloplegia is used in children with Down syndrome, cerebral palsy and other CNS disorders in whom there may be an increased reaction to cycloplegic agents.** In these cases, Tropicamide (1%) may be used as a dilating agent.

An appropriate distance target should be used to control fixation and any remaining accommodation. This may include a video or poster with appropriate details to keep the child's attention. If the child is verbal, asking questions about the target will help control fixation.

- **Near Retinoscopy/Mohindra Dark Retinoscopy:**

This is generally conducted by turning off all lights in the consulting room and encouraging the child to accommodate to the retinoscope light, without the use of cycloplegic drops. A working distance of approximately 50cm is used. Loose trial lenses are used to neutralise the retinoscopy reflex and 1.00D subtracted from the result to account for accommodation to target light.<sup>12,13</sup>

- **Simplified subjective refraction**

It might be appropriate and feasible in this age group to perform a simplified subjective refraction by utilising plus acceptance or binocular blur function testing methods. Refractive errors (including latent hyperopia) can be detected in some children with the capacity to understand the testing.

d. Binocular Vision/Accommodation

In this age group the following testing regimen may be useful in determining binocular vision status.

- **Cover test** (distance and near )
- **Hirschberg/ Bruckner**
- **Ocular Excursions**
- **Near Point of Convergence**
- **Monocular estimation method (MEM) retinoscopy**
- **Objective fusional vergence**
- **Distance and Near Phoria Measurement**

The cover test is the primary means of evaluating binocular vision in children. If a strabismus is found, measurement of the magnitude of the deviation can be determined using a prism bar. If a heterophoria is found on cover test, objective measurement of fusional vergence will assist in determining the need for treatment.

Extraocular muscles movement can also be assessed using either a pen torch or appropriate fixation target. An accommodative target can be used to assess near point of convergence.

### **Stereopsis**

Examples of suitable clinical tests to assess the child's stereopsis include:

- **Randot Stereo Test**
- **Titmus Fly**
- **Lang I & II**<sup>17</sup>
- **Frisby Test**
- **TNO stereo test**
- **Preschool Assessment of Stereopsis with a Smile test**<sup>18</sup>
- **Randot Preschool Stereacuity Test**<sup>19</sup>

*Tables 4 and 5 (see appendix)* shows the approximate stereoacuity expected for each age group.<sup>20</sup> Whilst there may be slight variations to this normative data, any major deviation requires further investigation to identify a possible cause.

### **Suppression**

Suppression testing in this age group is important in diagnosing or eliminating conditions of binocular vision disorders including strabismus, amblyopia, convergence insufficiency and aniseikonia. During the eye examination, the presence of suppression at various distances and the size and location of the suppression scotoma may be assessed using the Worth 4 dot test.<sup>21</sup>

### **Colour Vision**

Colour vision testing is essential in determining if the child is colour vision deficient from an early age.<sup>23</sup> The information is vital in classifying the child as colour vision deficient rather than suffering from learning and developmental delay. In addition, colour vision deficiency may indicate an ocular health problem which is why it is essential that all children are tested at a routine paediatric examination. Some of the common tests include

1. **Ishihara**
2. **Color Vision Testing Made Easy**<sup>22</sup>
3. **City University Colour Vision**<sup>29</sup>

### **Referral**

If a binocular vision disorder or limitation on ocular motility is suspected, referral to a paediatric optometrist or ophthalmologist may be warranted.

## e. Ocular Health Assessment

Ocular health assessment for a pre-school aged child may include:

- Gross inspection of the external features including lid anatomy
- Assessment of Pupillary Responses
- Assessment of the anterior segment
- Assessment of the posterior segment

Whilst this area of a paediatric eye examination can at times pose difficulty in instances where a child cannot follow instructions or cooperate for the duration of the assessment, it is essential that major eye disease is excluded during standard eye examinations. Standard procedures including tonometry, slit lamp assessment and binocular indirect ophthalmoscopy are much more difficult compared with older age groups.

Pupillary response can be assessed using an ophthalmoscope or hand held trans-illuminator. Direct, consensual and afferent pupil functions should be evaluated. A hand held or regular biomicroscope can then be used to evaluate the anterior ocular segment. The child may be seated in a parent or guardian's lap to maintain sufficient stability and accessibility by the practitioner.

Examination of posterior ocular structures may require pupillary dilation where clinically indicated. This may be in the presence of a chronic disease or where new symptoms are reported. Numerous population studies recommend the drug and dosage for safe pupil dilation to be one drop of Tropicamide (0.5% - 1%)<sup>24,25</sup>. Once the pupils are dilated, direct and indirect ophthalmoscopy can be conducted to assess the health of the posterior segment. If cycloplegic retinoscopy has been performed, ocular health assessment can be done in conjunction.

When adequate fundus examination is not possible but clinically essential (e.g. Leukocoria), referral for examination under anaesthesia may be warranted.

### **IOP in pre-school and early school-aged children where clinically indicated**

Although extremely rare in children, glaucoma may present in this age group.<sup>26</sup> Family history and existing ocular pathology in infants remain the strongest risk factors for congenital or infantile glaucoma.<sup>27</sup> In the event that intraocular pressures need to be measured, handheld applanation tonometry, non-contact tonometry or rebound tonometry may be used. It is important to note that in this age group, accuracy of these results can often be unreliable with limited concentration and cooperation from the child.

## f. Evaluation, Diagnosis & Management

It is important upon completion of the eye examination that all aspects are analysed for results that lie outside what is considered the normative data. This will help the optometrist to arrive at a diagnosis and establish a management plan. A clear and concise explanation to the parent or guardian must ensue, followed by an outline of the treatment protocol and expected review period. In instances where the management is beyond the scope and experience of the optometrist, referral for consultation or treatment by another optometrist, or other physician (e.g. paediatrician, ophthalmologist, general practitioner) is recommended.



**SECTION C: Clinical Practice Guide on the vision and eye health assessment and management of School-aged children**

**Paediatric Eye Examination of School-aged children (Age 7 years – 14 years).**

**Reason for Visit**

The components of an examination outlined below are not exhaustive and maybe be modified or supplemented as deemed necessary. Whilst communication and explanation of testing is possible in this age group, it is important for a parent or guardian to accompany the child in the consulting room. This will help in facilitating a response from some children as well as provide a certain level of comfort in an unfamiliar environment.

The presentation of this age group to general optometric practice will generally fall into five categories. These are:

<b>Reasons for visit</b>	
<b>Routine Eye Examination</b>	A parent may decide to bring their child in for routine eye examination in the absence of signs or symptoms
<b>Child symptomatic</b>	A child presents with specific symptoms
<b>Referral from other health care professional</b>	Referral or recommendation by a health care practitioner including general practitioner, paediatrician or other medical specialist
<b>Parental observation</b>	A parent or carer notices particular concerning behaviours which may include eye-rubbing, squinting, clumsiness or a significant turn to one or both eyes
<b>Family history</b>	A parent may decide to bring their child in for a routine examination or because a sibling or other relation has an existing eye problem
<b>Referral from other professional</b>	Referral by a cognitive or educational specialist (e.g. teacher or educational psychologist) who has noticed particular signs including squinting, difficulty seeing the board or missing lines whilst reading.

## Examination Sequence

### a. Patient History

A comprehensive history for a school aged child incorporates obtaining information from the parent or guardian and any referral. The child may also be questioned on any particular symptoms or difficulties they have noticed. Areas that need to be covered include:

- **Chief complaint:** Identification of the presenting complaint
- **Visual and previous ocular history:** Including patching, surgery, infections or injuries
- **General health history:** Including prenatal, perinatal and postnatal history e.g. type of childbirth and any associated complications
- **Family ocular and medical history:** Including eye conditions of siblings and other relations
- **Developmental history:** Attainment of expected developmental milestones
- **Behaviour:** Questioning around changes to behaviour and common habitual tasks
- **Performance:** History on academic and/or sporting performance
- **Screen time:** Time spent watching television
- **Near tasks:** Time spent using hand-held electronic devices or performing near activities

### b. Visual Acuity

Measurement of visual acuity in this age group is essential for early detection of any refractive error or previously undetected amblyopia.

**Clinical Pearl:** By age 6, it is expected that a child with “normal” vision records a visual acuity of 6/6. Visual acuities should be tested monocularly and binocularly, and if the child presents with spectacles, then also tested aided and unaided.

A Snellen chart at 6m is generally recommended. If a child is illiterate, consider the use of Lea symbols. Single line isolation may be considered in younger children in this category if they are having difficulty keeping their place on the acuity chart. It is important to note however that single line isolation may affect the detection of amblyopia in the absence of the crowding effect.

### c. Refraction

Conventional subjective refraction is considered difficult but not impossible in this age group due to short attention span and difficulty understanding instructions. The examiner should employ objective measures with which to quantify the child’s refractive error. Three of the most common techniques include:

- **Static (Dry) Retinoscopy**
- **Cycloplegic Retinoscopy**
- **Subjective Refraction**

### **Static (dry) Retinoscopy**

Using an acuity chart at 6 meters, retinoscopy without the use of cycloplegic drops can be performed whilst controlling accommodation. Use of a lens rack, loose lenses or a phoropter is suitable for this age group. It is important to have the child discussing an appropriate target to control accommodation such as a video or poster to obtain an accurate measurement. For older children in this age group, the use of a duochrome target with a large letter can also be used to relax accommodation. Static retinoscopy should be considered as the initial technique prior to considering other methods requiring cycloplegic drops.

### **Notes of the use of Cycloplegic drops**

In situations where the child's accommodation cannot be controlled, the use of 1% Cyclopentolate Hydrochloride can be considered. It is also important to consider the use of cycloplegia if there is a suspicion of or in the presence of strabismus and/or amblyopia. Cycloplegia will aid in obtaining an accurate refraction result.

One drop of 1% Cyclopentolate Hydrochloride<sup>10</sup> should be instilled in each eye twice – 5 minutes apart in each eye. Retinoscopy may be performed 45 minutes after administration of eye drops. It is important that overdosage is avoided in children with Down syndrome, cerebral palsy and other CNS disorders in whom there may be an increased reaction to cycloplegic agents. In these cases, Tropicamide (1%) may be used as a dilating agent.

An appropriate distance target should be used to control fixation and any remaining accommodation. This may include a video or poster with appropriate details to keep the child's attention. Asking questions about the target will also help control fixation.

### **Subjective Refraction**

For older children in this category, subjective refraction can be used to refine the retinoscopy findings.

#### **d. Binocular Vision/Accommodation**

The following testing regimen may be useful in determining binocular vision status of children in this category.

- **Cover test** (distance and near)
- **Near Point of Convergence**
- **Near Point of Accommodation – monocularly**
- **Positive and negative fusional vergences**
- **Positive and negative relative accommodation**
- **Accommodative convergence/accommodation (AC/A) ratio**
- **Accommodative facility**
- **Vergence facility**
- **Monocular estimate method (MEM) retinoscopy**
- **Ocular Excursions**
- **Distance and Near Phoria measurement**

**Clinical Pearl:** *Table 2 (see appendix)* provides standard testing protocol and a guide to clinical normative values for accommodation and vergence parameters.

Extraocular muscle movements can also be assessed using either a pen torch or appropriate fixation target. An accommodative target can be used to assess near point of convergence.

Children in this age group may require some binocular vision tests conducted and relevant accommodative and vergence parameters measured in order to accurately diagnose any binocular vision issues. This will then determine the management and treatment required. *Table 2 (see appendix)* outlines the tests available and normative values expected in a binocular vision assessment.<sup>30-38</sup>

### Stereopsis

Examples of suitable clinical tests to assess the child's stereopsis include:

- **Titmus Fly**
- **Randot Stereo Test**
- **Lang I & II**<sup>17</sup>
- **Frisby Test**
- **TNO stereo test**
- **Preschool Assessment of Stereopsis with a Smile test**<sup>18,19</sup>

### Suppression

Suppression testing in this age group is important in diagnosing or eliminating conditions of binocular vision disorders including strabismus, amblyopia, convergence insufficiency and aniseikonia. During the eye examination, the presence of suppression at various distances and the size and location of the suppression scotoma may be assessed using the **Worth 4 dot test**.<sup>21</sup>

### Colour Vision

Colour vision testing is essential in determining if the child is colour vision deficient from an early age. The information is vital in classifying the child as colour vision deficient rather than suffering from learning and developmental delay. In addition, colour vision deficiency may indicate an ocular health problem which is why it is essential that all children are tested at a routine paediatric examination. Common tests include:

1. **Ishihara**
2. **Color Vision Testing Made Easy**<sup>22</sup>
3. **City University Colour Vision Test**<sup>29</sup>

### Referral

If a binocular vision disorder or limitation on ocular motility is suspected, referral to a specialised paediatric optometrist or ophthalmologist may be warranted.

## e. Ocular Health Assessment

Ocular health assessment for a school-aged child may include:

- Gross inspection of the external features including lid anatomy
- Assessment of Pupillary Responses
- Assessment of the anterior segment
- Assessment of the posterior segment

Whilst this area of a paediatric eye examination can pose some difficulty in younger school-aged children, it is essential that major eye disease is excluded during standard eye examinations.

Pupillary response can be assessed using an ophthalmoscope or hand held trans-illuminator. Direct, consensual and afferent pupil functions should be evaluated. Children in this age group will mostly cooperate and allow use of the slit lamp to evaluate the anterior segment.

Examination of posterior ocular media may require pupillary dilation where clinically indicated. This may be in the presence of a chronic disease or significant sight threatening symptoms or signs. Numerous population studies recommend the drug and dosage for safe pupil dilation to be one drop of Tropicamide (0.5% - 1%)<sup>24, 25</sup>. Once the pupils are dilated, direct and indirect ophthalmoscopy can be conducted to assess the health of the posterior segment. If cycloplegic retinoscopy has been performed, ocular health assessment can be done in conjunction.

Digital retinal imaging is also recommended as a means of early detection, monitoring or assist in the determination of management of ocular disease in the presence of risk factors. Additional ocular imaging techniques such as Optical Coherence Tomography (OCT), digital anterior imaging or corneal topography may also be useful in detecting and/or documenting ocular pathology.

When adequate fundus examination is not possible, referral for examination under sedation or anaesthesia may be warranted.

### **IOP in children aged 7-12 where clinically indicated**

Although rare in children, glaucoma may present in this age group and a baseline measurement at this age is valuable.<sup>26</sup> In the event that intraocular pressures need to be measured, handheld applanation tonometry, non-contact tonometry or rebound tonometry may be used. It is important to note that for younger children in this age group, accuracy of these results can often be unreliable with limited concentration and cooperation from the child.

## f. Evaluation, Diagnosis & Management

It is important upon completion of the eye examination that all aspects are analysed for results that lie outside what is considered the normative data. This will help the optometrist to arrive at a diagnosis and establish a management plan. A clear and concise explanation to the parent or guardian and the child who has been examined (depending on their age and comprehension) must ensue, followed by an outline of the treatment protocol and expected review period. In instances where the management is beyond the scope of the optometrist, referral for consultation or treatment by another optometrist, or other physician (e.g. paediatrician, ophthalmologist, general practitioner) is recommended.

## **Conclusion**

It is essential for children of all age groups present for a preventative eye health and vision examination at regular intervals or when a child, their parent/guardian, healthcare practitioner or educational specialist recommends an eye examination. 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. Important preventative health advice for paediatric patients includes minimising screen time, (use of computers, tablets, etc.) a balanced diet, appropriate UV protection through the use of sunglasses and regular eye examinations.

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**Table 1: Available Testing Procedures by Age**

Testing Procedures Available to Clinicians			
Test/ Procedure	Birth – 2 years, 11 Months	3 years –6 years, 11 Months	7 years – 14 years
<b>Patient History</b>	Parent	Parent/Child	Parent/Child
<b>Visual Acuity</b>	<ul style="list-style-type: none"> <li>• Fixation Preference</li> <li>• Preferential Looking Test                             <ul style="list-style-type: none"> <li>- Teller Acuity Cards</li> <li>- Lea Paddles</li> </ul> </li> <li>• Patti Pics</li> <li>• Lea Chart</li> <li>• Cardiff Cards</li> </ul>	<ul style="list-style-type: none"> <li>• Lea Chart at 3m</li> <li>• Patti Pics at 3m</li> <li>• Snellen Chart at 6m</li> <li>• Broken Wheel Test</li> </ul>	<ul style="list-style-type: none"> <li>• Snellen Chart at 6m</li> <li>• Near visual acuity</li> </ul>
<b>Refraction</b>	<ul style="list-style-type: none"> <li>• Static (Dry) Retinoscopy</li> <li>• Cycloplegic Retinoscopy</li> <li>• Mohindra Retinoscopy</li> </ul>	<ul style="list-style-type: none"> <li>• Static (Dry) Retinoscopy</li> <li>• Cycloplegic Retinoscopy</li> <li>• Mohindra Retinoscopy</li> <li>• Topography</li> </ul>	<ul style="list-style-type: none"> <li>• Static (Dry) Retinoscopy</li> <li>• Cycloplegic Retinoscopy</li> <li>• Subjective Refraction</li> <li>• Blur Function</li> <li>• Topography</li> </ul>
<b>Binocular Vision Testing</b>	<ul style="list-style-type: none"> <li>• Cover test</li> <li>• Hirschberg test</li> <li>• Krimsky test</li> <li>• Bruckner test</li> <li>• Ocular Excursions</li> <li>• Near Point of Convergence</li> <li>• Dolls eye reflex</li> <li>• Worth 4 Dot</li> </ul>	<ul style="list-style-type: none"> <li>• Cover test</li> <li>• Hirschberg/ Bruckner</li> <li>• Ocular Excursions</li> <li>• Near Point of Convergence</li> <li>• Monocular estimation method (MEM) retinoscopy</li> <li>• Objective fusional vergence</li> <li>• Distance and Near Phoria Measurement</li> <li>• Near Point of Accommodation</li> <li>• Worth 4 Dot</li> </ul>	<ul style="list-style-type: none"> <li>• Cover test at distance and near</li> <li>• Ocular Excursions</li> <li>• Near Point of Convergence</li> <li>• Monocular estimate method (MEM) retinoscopy</li> <li>• Near Point of Accommodation – monocularly</li> <li>• Positive and negative fusional vergences</li> <li>• Positive and negative relative accommodation</li> <li>• Accommodative convergence/accomm odation (AC/A) ratio</li> <li>• Accommodative facility</li> <li>• Vergence Facility</li> <li>• Distance and Near Phoria Measurement</li> <li>• Worth 4 Dot</li> </ul>

Test/ Procedure	Birth – 2 years, 11 Months	3 years –6 years, 11 Months	7 years – 14 years
<b>Stereopsis</b>	<ul style="list-style-type: none"> <li>• Lang I &amp; II</li> <li>• Titmus Fly</li> <li>• Randot Stereo Test</li> <li>• Frisby Test</li> <li>• TNO Stereo Test</li> <li>• Preschool Assessment of Stereopsis with a Smile Test</li> <li>• Randot Preschool Stereoacuity Test</li> </ul>	<ul style="list-style-type: none"> <li>• Lang I &amp; II</li> <li>• Titmus Fly</li> <li>• Randot Stereo Test</li> <li>• Frisby Test</li> <li>• TNO Stereo Test</li> <li>• Preschool Assessment of Stereopsis with a Smile Test</li> <li>• Randot Preschool Stereoacuity Test</li> </ul>	<ul style="list-style-type: none"> <li>• Lang I &amp; II</li> <li>• Titmus Fly</li> <li>• Random Dot Stereogram</li> <li>• Frisby Test</li> <li>• TNO Stereo Test</li> <li>• Preschool Assessment of Stereopsis with a Smile Test</li> </ul>
<b>Colour Vision Assessment</b>	<ul style="list-style-type: none"> <li>• Color Vision Testing Made Easy (for older children in this age group)</li> </ul>	<ul style="list-style-type: none"> <li>• Ishihara</li> <li>• Color Vision Testing Made Easy</li> <li>• City University Colour Vision</li> </ul>	<ul style="list-style-type: none"> <li>• Ishihara</li> <li>• Color Vision Testing Made Easy</li> <li>• City University Colour Vision</li> </ul>
<b>Ocular Health Assessment</b>	<ul style="list-style-type: none"> <li>• Gross inspection of the external features, including lid anatomy</li> <li>• Assessment of Pupillary Responses</li> <li>• Assessment of the anterior segment</li> <li>• Assessment of the posterior segment</li> <li>• IOP where clinically indicated</li> <li>• Topography where clinically indicated</li> <li>• Digital Retinal Imaging where clinically indicated</li> <li>• Optical Coherence Tomography where clinically indicated</li> </ul>		

**Table 2: Binocular Vision Testing and Range for Visual Efficiency for Children**

Guide to Clinical Range for Visual Efficiency for Accommodation and Vergence Parameters				
Parameter	Vergence Test	Normative Value	Accommodation Test	Normative Value
Posture	Near Phoria Distance Phoria	3 pd exo $\pm$ 4 <sup>1</sup> 1 pd exo $\pm$ 1 <sup>2</sup>	Near Retinoscopy	+0.50DS $\pm$ 0.25 <sup>3</sup>
Amplitude	<b>NPC:</b> Break Recovery	$\leq$ 5cm $\leq$ 7cm <sup>4</sup>	Near Point of Accommodation	$\geq$ 15D – 0.25 (age) <sup>5</sup>
Range	Near Base In Near Base Out Distance Base In Distance Base Out	$\geq$ 10/16/10 $\geq$ 12/18/11 $\geq$ 7/4 $\geq$ 14/7 <sup>6</sup>	Relative Accommodation	$\pm$ 2.00D at near -2.00D at distance <sup>5</sup>
Facility	3pd BI/12pd BO flipper <sup>7</sup>	15 cycles per minute at near	$\pm$ 1.00D Flipper $\pm$ 2.00D Flipper	8 cycles per minute at near with $\pm$ 2.00D flipper <sup>8</sup>
Interaction	AC/C Ratio 2.2pd/D $\pm$ 0.8 (consider ratio to + and – lenses separately) <sup>9</sup>			

\*Taken from Fricke T, Dinardo C. *Vision Therapy Guidelines for Visual Efficiency 2014*

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**Table 3: Normative Visual Acuity by Age**

Mean visual acuity by age		
Age (months)	Age (years)	Snellen Visual Acuity
30-35 months	2½ - 3	6/19
36-47 months	3 – 4	6/15
48-59 months	4 – 5	6/12
60-72 months	5 – 6	6/9.5

**Taken from** Pan Y, Tarczy-Hornoch K, Cotter S, Wen G, Borchert M, Azen S, Varma R. Visual Acuity Norms in Pre-School Children: The Multi-Ethnic Pediatric Eye Disease Study. *Optometry and Vision Science*. Vol 86. No 6. June 2009.

**Table 4: Average Stereoacuity by Age**

Average Stereoacuity by Age	
Age (years)	Stereoacuity Level (Seconds of arc)
3	111.24
4	98.1
5	88.68

**Taken from** Ciner E, Ying G, Kulp M, Maguir M, Quinn G, Orel-Bixler D, Cyert L, Moore B, Huang J. Stereoacuity of Preschool Children with and without Vision Disorders. *Optometry and Vision Science*. Vol 91. No. 3, March 2014.

**Table 5: Normative Data – Randot Pre-school Stereoacuity Norms**

Age (Years)	Three-book version		Four-book version	
	Mean (Seconds of Arc)	Lower limit (Seconds of Arc)	Mean (Seconds of Arc)	Lower limit (Seconds of Arc)
3	100	400	100	400
4	100	200	100	200
5	60	200	60	200
6	60	100	40	100
7 – 8	40	60	30	60
9 – 10	40	60	30	60

**Taken from** Birch E, Williams C, Drover J, Cheng C, Northstone K, Courage M, Adams R. Randot Preschool Stereoacuity Test: Normative Data and Validity. *Journal of American Association for Pediatric Ophthalmology and Strabismus*. 2008. Vol 12, Issue 1: 23-26.

**Table 6: Average Refractive Error (30-72 Months)**

	Average Refractive Error (Children aged 30-72 months)	
Age (Months)	Refractive Error	Prevalence
30 – 72 Months	-1.00D	2.5%
	0.00D	11%
	+1.00D	52.5%
	+2.00	27.5%
	+3.00	4%
	+4.00	0.5%

**Taken from** Shih-I Pai A, Rose K, Leone J, Sharbini S, Burlutsky G, Varma R, Wong T, Mitchell P. Amblyopia Prevalence and Risk Factors in Australian Preschool Children. [Ophthalmology](#). [Volume 119, Issue 1](#), January 2012:138–144