A simple and efficient approach to conducting an eye examination for infants, toddlers, and preschool children is presented. Age-appropriate techniques for the assessment of visual acuity, eye alignment, stereopsis, refractive error, and ocular health are discussed. Clinical pearls for maximizing patient cooperation are provided.

Learning Objectives:
1. Recall the minimum clinical testing needed for comprehensive eye examinations of infants and young children.
2. Recall current and age-appropriate evaluation methods for visual acuity, ocular alignment, refraction, stereopsis, color vision, & eye health status.
3. Understand why a cycloplegic refraction is the preferred method of refraction for infants and young children.
4. Use recent published normative data to help determine if a 3 to 6-year-old child’s visual acuity and stereopsis are within normal limits.
5. Comfortably and confidently conduct pediatric eye exams in a primary eye care practice.

I. Introduction
1. Course objectives
2. Rationale for eye examinations
   • Early detection & treatment to maximize child’s potential
   • Prevent vision loss and/or loss of binocularity
   • Detect and treat vision problems that can potentially affect development or learning
   • Treatment often easier because of plasticity of visual system
3. U.S. Preventive Services Task Force (USPSTF) recommends children 3 - 5 years be screened at least once to detect amblyopia & amblyogenic risk factors such as strabismus & significant refractive error.
4. Children who should bypass vision screenings and go directly for eye exams?
   • Readily recognized eye abnormalities such as strabismus or ptosis
   • Known neurodevelopmental disorders (e.g., hearing impairment, motor abnormalities such as cerebral palsy, Down syndrome, cognitive impairment, autism spectrum disorders, or speech delay)
   • With systemic diseases or using medications known to cause eye disorders
   • Positive family history of first-degree relative with strabismus or amblyopia
   • Born prematurely at <32 completed weeks of gestation
   • Parent or guardian believes child may have a vision-related problem
5. Recommended examination ages per AOA:
   • Asymptomatic / no risk: 6 months; 3 years; before first grade
   • At risk: by 6 months or as recommended; 3 years or as recommended; annually or as recommended ≥6yrs
II. Examination Strategy

1. General Guidelines
   • Timing is important; make sure the child will not be tired or hungry at exam; scheduler needs to consider nap times
   • Advise parent to bring snacks and toys; preferably leave other young children at home or bring another adult to watch them
   • Have child friendly waiting room and exam room
   • Be flexible about where / how you examine a child; depending on age, child may sit in examine chair, on parent’s lap, in stroller or alternative chair, or in parent’s arms during parts of exam
   • Identify specific toys/characters that child likes so can use during examination
   • Before beginning examination procedures, talk with child to establish rapport
   • Provide rewards (treasure chest, stickers) after difficult parts of exam (dilating drops, ocular health evaluation)

   • Considerations for patients with special needs
     – Identify specific sensitivities (light, sound, touch) prior to examination
     – Obtain history information ahead of time if possible
     – May have to see patient more than once to obtain all needed data

2. Case History
   • Chief complaint
   • Signs and symptoms
   • Ocular health hx
   • Medical health hx (allergies/medications)
   • Pre- & peri-natal hx
     – Birth weight (low birth weight <2500 g)
     – Preterm <37 weeks
     – APGAR score (>7, 3 minimum)
     – Type of birth (natural, cesarean)
     – Complications during pregnancy, birth, or immediately after birth
       o Exposure to drugs in utero, maternal health issues during pregnancy, oxygen or other interventions after birth
   • Developmental Hx
     – Developmental milestones: crawl, walk, talk
   • Academic Hx
     – Easiest and most difficult subject in school
     – Grades repeated
     – Age entering first grade
     – Tutoring or remedial assistance
     – Learning or behavioral problems
   • Ocular and medical family hx
3. Routine Examination (Minimum data base)
   - Monocular visual acuities: equal and normal VA?
   - Refractive error: magnitude that would place at risk for strabismus, amblyopia, or other visual problems or symptoms
   - Ocular alignment: strabismus present?
   - Ocular Health: sight or life threatening?
   - Color Vision (preschoolers)

4. Visual Acuity
   A. Objective
      - Direct vs. indirect measures
   B. Testing Infants
      - Teller acuity cards
        - Forced choice preferential looking test
        - Ideal for patients less than 1 year old
        - Test at 38cm (< 6 months), 55cm (7 mo to 3 yrs), 84 cm (> 3 years)
      - Patti Pics Patti Stripes
        - Forced choice preferential looking test
        - Two paddles, one gray, one with grating
        - 25, 50, 100 cm testing distance
      - Lea paddles
        - Forced choice preferential looking test
        - Two paddles, one is gray, one with grating
        - Sensitivity
          - Any amblyopia = 31% (17/55)
          - Anisometropic amblyopia = 20% (8/40)
          - Strabismic amblyopia = 80% (8/10)
        - False Positives
          - High number of strabismic children
          - Of strabismic kids with grade C/D FP, only 32% (8/25) had amblyopia
      - Resistance to occlusion
      - Fix and follow
   C. Testing Toddlers: Cardiff cards
      - Preferential looking with vanishing optotypes
      - Ideal for patients 1-3 years and those with special needs
      - Picture (duck, train, boat, fish, house) located on top or bottom half
      - Test VA until cannot identify placement correctly 2/3 times
D. Testing Preschoolers

- Desired characteristics of Preschool VA test (Fern & Manny, 1986)
  - High contrast, single, isolated optotypes
  - 2-alternative forced choice or matching
  - Avoidance of verbal or directional response
  - Reduced testing distance (3m)
  - Crowding bars: better amblyopia detection than letters without

- Other desired characteristics
  - logMAR steps
  - Inability to memorize

- Best tests: 1) HOTV or 2) Lea symbols
  - H, O, T, and V: vertical symmetry
  - Lea symbols:
    - 4 well standardized optotypes (house, heart/apple, circle, square)
    - Blur equally & scaled to reflect comparable VA’s obtained with Snellen letters
  - Most ≥ 3 years can successfully complete VA testing with both kinds
  - Formats: hand-held cards or computer based; MassVAT is rectangular bar surround line of letters

- General considerations
  - Demonstrate task to child first
  - Use lap card for matching
  - Careful with monocular occlusion
    - Adhesive patch
    - Micropore™ or Blenderm™ hypoallergenic surgical tape
    - Special occluder glasses

- Tests NOT recommended - should be replaced:
  - Landolt C and Tumbling E
  - Lighthouse cards
  - Allen Preschool Vision Test & Kindergarten Eye Chart
    - Not standardized & variable inter-line gap widths and shape cues; thus, some pictures more readily identified than others
    - Some cultural bias and some outdated pictures
    - Pictures not readily recognizable by all children
• **Normative VA** (Pan et al., MEPEDS; *Optom Vis Sci* 2009;86(6):607-12)

Mean logMAR VA & Thresholds for Lowest 5th Percentile

<table>
<thead>
<tr>
<th>Age (Mos)</th>
<th>Mean (SD) logMAR VA Snellen Equiv</th>
<th>5th %ile (Snellen equiv.)*</th>
<th>Snellen equiv. threshold †</th>
<th>% children with worse acuity</th>
<th>Alternate threshold Snellen equiv††</th>
<th>% children with worse acuity</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-35</td>
<td>0.24 (0.15) 20/35</td>
<td>0.49 (20/62)</td>
<td>20/63</td>
<td>4.2%</td>
<td>20/50</td>
<td>7.6%</td>
</tr>
<tr>
<td>36-47</td>
<td>0.17 (0.13) 20/30</td>
<td>0.38 (20/48)</td>
<td>20/50</td>
<td>2.9%</td>
<td>20/40</td>
<td>6.5%</td>
</tr>
<tr>
<td>48-59</td>
<td>0.09 (0.11) 20/25</td>
<td>0.27 (20/37)</td>
<td>20/40</td>
<td>1.1%</td>
<td>20/32</td>
<td>4.6%</td>
</tr>
<tr>
<td>60-72</td>
<td>0.02 (0.09) 20/21</td>
<td>0.17 (20/30)</td>
<td>20/32</td>
<td>0.8%</td>
<td>20/25</td>
<td>9.0%</td>
</tr>
</tbody>
</table>

†Nearest Snellen-equivalent line tested by ATS HOTV protocol.
†† Alternate threshold is next better VA level

5. **Refractive Error Assessment**
   A. **Static vs. cycloplegic retinoscopy**
   - Indications
   - Procedure
   B. **Autorefraction**
   - Young patients often overminused or missed hyperopia
   - Consider using after cycloplegia only
   C. **Mohindra near retinoscopy**
   - Indications - Unable to cyclopege
   - Procedure
     - Dark room, one eye occluded
     - 50cm testing distance
     - Patient looks at retinoscope light
     - Subtract 1.25D from gross retinoscopy finding
   - Accuracy
     - Not equivalent to cycloplegic refraction: generally less plus than cycloplegic retinoscopy

6. **Ocular Alignment Assessment**
   A. **Direct observation**: strabismus?, head postures; lid fissure width, facial asymmetry
   B. **Cover testing**
   - Control fixation and accommodation: use small age-appropriate interesting target
   C. **Hirschberg/Kappa**: binocular corneal reflex test
   - Determines direction & estimated magnitude of strabismus
   - Compare to Angle Kappa (lambda) under monocular conditions
   - 1 mm = 22 Δ
D. Krimsky: estimate of magnitude of strabismus
   • Start with Hirschberg
   • Add appropriate base prism over deviated eye until corneal reflexes symmetrical

E. Brückner
   • Dim room, approx 1 m test distance, patient optically corrected
   • Performed without pupil dilation
   • Shine direct ophthalmoscope at bridge of nose, illuminating both pupils simultaneously
   • Patient instructed to look at light
   • Compare brightness & whiteness of fundus reflexes through pupils
   • Eye with "whiter & brighter" reflex suggested to be strabismic (assuming optically corrected)
   • Not reliable until 8 mo. of age
   • Huang/MEPEDS data

7. Stereopsis Testing
   A. Lateral disparity
      • Titmus Stereo-fly, Stereo reindeer, animals, Wirt circles
      • Also some lateral disparity on many of the Randot books (1 side)
      • Monocular cues are problematic
   B. Random dot stereopsis –monocular cues absent; generally indicates bifixation
      • Randot Test
      • Randot LEA Symbols Stereoacuity Test
      • Random Dot E (RDE)
      • Lang Stereotest
         o No polarized glasses needed
      • Randot Preschool Stereoacuity Test
      • Distance Randot
      • Stereo Smile Test / PASS test

8. Extraocular muscles – versions
   • Voluntary - Move target –
      o Use penlight / transilluminator or toys for target
      o Restrain head movement
   • Involuntary: Doll's head phenomenon
      o Move child’s head

G. Ocular Health Assessment
   • Timing
   • Pupil evaluation
   • Color vision
      – Color Vision Testing Made Easy Test
      – Waggoner HRR
• IOP
  – TonoPen
  – Keeler Pulsair
    – No anesthesia needed
    – Non-contact tonometer
  – iCare
    – No anesthesia needed
    – Rebound tonometer
  – Goldmann tonometry
  – Other
    – Tactile pressures???
• Dilation
  – Tropicamide
  – Phenylephrine
  – May use dilation spray in young children
• External ocular structures
  – 20D lens and BIO or 20D lens and transilluminator
  – Bluminator®
  – Hand-held slit lamp
• Internal ocular structures
  – 20D lens with BIO or transilluminator
  – Direct ophthalmoscope

H. Supplemental Testing
• Near visual acuity; binocular okay for typical exam
• Saccades and pursuits
• Accommodation
  – Amplitude (monocular) – can do pull away
  – Accuracy – MEM to measure lag/accuracy
• Second degree fusion
  – Worth 4 dot
  – Pediatric flashlight
    – Fusion, suppression, diplopia responses
• Vergence ranges