Pediatric Hearing Assessment

This booklet is designed to supplement the Phonak Video Focus “Pediatric Hearing Assessment”. The figures and references contained were selected to further clarify and/or direct interested readers to pertinent literature concerning appropriate screening and assessment procedures for infants and young children that are overviewed in the videotape.

The booklet has been organized according to four basic audiological screening and assessment topics reviewed; namely, hearing loss identification in the newborn period, physiologic tests of middle ear and cochlear function, electrophysiologic (frequency-specific) auditory brainstem response (ABR) procedures, and behavioral audiometry techniques. In addition, references are provided on the development of a pediatric evaluation protocol (test battery) and on the family-centered approach to hearing screening, assessment and management.

Screening and the comprehensive evaluation of hearing are important components of the early habilitation process. The accurate and timely detection and delineation of hearing loss allows appropriate amplification to be provided to the infant or young child. The use of prescriptive hearing aid fitting procedures is addressed in the companion videotape “Pediatric Hearing Instrument Fittings” in this Phonak Video Focus Series.
Newborn and Infant Hearing Screening

Due to pre- or perinatal complications or to family history, certain newborns are at higher risk for hearing loss than other babies born without such backgrounds. Moreover, other factors that occur early in childhood place some children who experienced typical birth histories at risk for later onset, progressive or acquired hearing loss.

High-risk indicators for hearing loss proffered by the U.S. Joint Committee on Infant Hearing (JCIH, 1994) are delineated in Table 1. Risk indicators are provided for the age periods:

1. Birth to 28 days,
2. 29 days to 2 years, and
3. 29 days to 3 years for infants requiring monitoring for progressive, late-onset, and acquired, hearing loss.

The JCIH 1994 Position Statement also recommends early detection of hearing loss throughout childhood and comprehensive assessment and follow-up.

Table 1

<table>
<thead>
<tr>
<th>Indicators Associated with Hearing Loss</th>
<th>JCIH 1994</th>
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<tbody>
<tr>
<td><strong>Birth to 28 days</strong></td>
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<tr>
<td>- Family history of hereditary childhood sensorineural hearing loss.</td>
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<td>- In-utero infection (e.g., TORCH).</td>
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<td>- Craniofacial anomalies.</td>
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<td>- Birthweight &lt; 1500 g.</td>
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<td>- Hyperbilirubinemia at serum level requiring exchange transfusion.</td>
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<td>- Ototoxic medications including but not limited to the aminoglycosides used in multiple courses or in combination with loop diuretics.</td>
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<td>- Bacterial meningitis.</td>
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<td>- Apgar scores of 0–4 at 1 minute or 0–6 at 5 minutes.</td>
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<td>- Mechanical ventilation ≥ 5 days.</td>
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<tr>
<td>- Stig mata or other findings associated with a syndrome known to include sensorineural and/or conductive hearing loss.</td>
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**29 days to 2 years**

- Parent/caregiver concern regarding hearing, speech, language, and/or developmental delay.
- Bacterial meningitis and other infections associated with hearing loss.
- Head trauma with loss of consciousness or skull fracture.
- Stig mata associated with syndromes known to include hearing loss.
- Ototoxic medications including but not limited to the aminoglycosides used in multiple courses or in combination with loop diuretics.
- Recurrent or persistent Otitis Media with Effusion (OME) for a period of at least 3 months.
In Need of Monitoring: 29 days to 3 years

- Family History of hereditary childhood hearing loss.
- In-utero infections: CMV, rubella, syphilis, herpes or toxoplasmosis.
- Neurofibromatosis Type II and neurodegenerative disorders.
- Conductive hearing loss indicators: OME, anatomic deformities, neurodegenerative disorders.

Hearing loss is often identified late in childhood. The first three years of life is a period important for oral/aural speech and language acquisition. In response to this problem, in 1993, a panel formed by the U.S. National Institutes of Health (NIH) developed a Consensus Statement titled Early Identification of Hearing Impairment in Infants and Young Children. In the Statement, the NIH recommended screening for hearing loss be completed before the newborn is discharged from the hospital or within the first 3 months of life. Follow-up recommendations and research goals were also provided. Table 2 highlights the primary points made in the 1993 NIH Consensus Statement.

Table 2

<table>
<thead>
<tr>
<th>NIH Consensus Statement 1993</th>
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<tbody>
<tr>
<td>All infants admitted to the Neonatal Intensive Care Unit (NICU) should be screened for hearing loss prior to discharge from the hospital.</td>
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<tr>
<td>Universal screening should be implemented for all infants within the first 3 months of life, preferably before discharge from the hospital.</td>
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<td>Hearing screening techniques should be rapid, reliable, highly sensitive, specific, and easy to administer by trained and supervised personnel.</td>
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<td>A two-stage screening process should be used. Evoked Otoacoustic Emissions (EOAE) should be used for the initial screening. Babies failing EOAE should be rescreened using the Auditory Brainstem Response (ABR). (Those passing ABR rescreen should return for rescreen at 3–6 months of age.)</td>
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<tr>
<td>Babies failing ABR rescreen should be referred for diagnostic audiological evaluation to:</td>
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<td>- verify the existence of a hearing loss and to determine the type and severity of the impairment;</td>
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<tr>
<td>- to initiate a remediation program for the infant and family</td>
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</tbody>
</table>
Selected References:


Copies may be obtained from the Office of Medical Applications of Research, National Institutes of Health, Federal Building, Room 618, Bethesda, MD 20892.


Phonak Video Focus Series #1: Pediatric Hearing Assessment

Physiologic Assessment Procedures

Selected References:


Behavioral Tests

Behavioral audiologic test techniques for infants and young children can be divided into two general categories: those that rely on observations of behavior (unconditioned response procedures) versus those that use operant conditioning techniques (conditioned response procedures) to maintain responding over repeated test trials. The outline provided in Figure 1 classifies the behavioral techniques reviewed in the videotape.

Figure 1

![Behavioral Audiometry Diagram](image-url)
Visual reinforcement audiometry (VRA) is a very useful test technique for infants beginning at 5 to 6 months of age. The availability of visual reinforcement for correct head-turn responding is critical to the success of operant audiometry. Practice of VRA is not restricted to the test suite arrangement depicted in the videotape. In the figures below, alternative arrangements for VRA testing are provided. (S = Loudspeaker; A = Audiologist; P = Parent; I = Infant; TA = Test Assistant; HC = High Chair; T = Table; VR = Visual Reinforcer unit.)

Figure 2

Figure 3

Figure 4

Figure 5 depicts four audiograms obtained from four 9-month-old infants using the VRA technique. Note that ear-specific and frequency-specific responses were obtained by air-conduction and that information from unmasked bone conduction was also obtained. Audiogram A – normal hearing; Audiogram B – conductive hearing loss secondary to otitis media; Audiogram C – severe cochlear hearing loss bilaterally; Audiogram D – unilateral hearing loss.
Table 3 provides mean sound field threshold data (in dB HL, rounded to the nearest 5 dB audiometric step) obtained using a computerized VRA procedure. Thresholds are provided at 500, 1000, 2000 and 4000 Hz. Data are displayed for infants ages 5, 7, 10 and 12 months of age. Babies had normal tympanograms at the time of test. The data of between 40 and 49 babies were considered in each age category and for each frequency. Numbers in parentheses refer to variability (standard deviation) again, rounded to the nearest 5 dB. (Data based on Gravel and Wallace, 1997).

### Table 3

<table>
<thead>
<tr>
<th>Age</th>
<th>500 Hz</th>
<th>1000 Hz</th>
<th>2000 Hz</th>
<th>4000 Hz</th>
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<tbody>
<tr>
<td>5 months</td>
<td>20 dB HL (15)</td>
<td>25 dB HL (15)</td>
<td>25 dB HL (15)</td>
<td>25 dB HL (15)</td>
</tr>
<tr>
<td>7 months</td>
<td>10 dB HL (10)</td>
<td>10 dB HL (10)</td>
<td>10 dB HL (10)</td>
<td>10 dB HL (10)</td>
</tr>
<tr>
<td>10 months</td>
<td>10 dB HL (5)</td>
<td>10 dB HL (10)</td>
<td>10 dB HL (10)</td>
<td>10 dB HL (5)</td>
</tr>
<tr>
<td>12 months</td>
<td>15 dB HL (5)</td>
<td>15 dB HL (10)</td>
<td>15 dB HL (10)</td>
<td>10 dB HL (10)</td>
</tr>
</tbody>
</table>

Selected References:


**Electrophysiologic Assessment Procedures**

**Selected References:**


**Test Battery in Pediatric Assessment**

When assessing the hearing of infants and young children, it is important to adopt a test-battery approach. Such an assessment protocol is in keeping with the principles delineated by Jerger and Hayes (1976) that supported use of a “cross-check approach” to pediatric assessment. Figure 6 presents test protocols that are useful in the assessment of infants and young children. The protocols are modeled after those recommended by ASHA (1991), Chase et al. (in press), and Chase and Gravel (1996).

**Selected References:**


Figure 6: Example of Pediatric Protocol

Identification of Risk for Hearing Loss
(Newborn: EOAE or ABR
Older child: EOAE, ABR or Behavioral)

Comprehensive Audiologic Assessment

Birth to 4 months 5 to 24 months 24 months to 4 years
Freq. Spec. ABR (min. 5 k and 2 kHz) VRA Play Audiometry
EOAE EOAE EOAE
Immittance Immittance Immittance
BOA (as cross-check) Freq. Spec. ABR (as necessary) Freq. Spec. ABR (as necessary)

EOAE: Evoked Otoacoustic Emissions
ABR: Auditory Brainstem Response
Freq. Spec.: Frequency Specific
VRA: Visual Reinforcement Audiometry
BOA: Behavioral Observation Audiometry

Family-Based Approach

Selected Reference: