

AGBell Association's Recommended Protocol for Audiological Assessment, Hearing Aid and Cochlear Implant Evaluation and Follow-up

Introduction

This audiological protocol is intended to support programs for early detection and management of hearing impairment, in infants and children. This protocol also is a guide to appropriate and ongoing audiology services recommended for children participating in listening and spoken language (LSL) programs.

The AG Bell Association recognizes and recommends an audiological protocol that includes the test battery approach as an optimum means to access spoken language. No single test should be used in isolation to define and describe the nature and extent of a hearing loss. Ideally, every listening and spoken language program will have on-site audiological services. But regardless of setting, close collaboration of parents, audiologists, therapists and educators is essential. Parents should be present and participate in all assessments. The Listening and Spoken Language Specialist (LSLS) also should be present at audiological assessments whenever possible or communicate his/her questions or concerns regarding the child's hearing or technology.

The recommended procedures and elements in this document are consistent with the following guidelines and position statements:

- Joint Committee on Infant Hearing (JCIH). (2007). Year 2007 Position Statement: Principles and guidelines for early hearing detection and intervention programs. *PEDIATRICS*, 120 (4), 898-921.
- American Speech-Language-Hearing Association. (2004a). *Guidelines for the audiological assessment of children from birth to 5 years of age*. Available at <http://www.asha.org/members/deskref-journals/deskref/default>.
- American Speech-Language-Hearing Association. (2006). *Roles, knowledge, and skills: Audiologists providing clinical services to infants and young children birth to 5 years of age*. Available at <http://www.asha.org/members/deskref-journals/deskref/default>.
- American Academy of Audiology Clinical Practice Guidelines: Pediatric Amplification, 2013. (www.audiology.org).

Overview of Audiological Management

- Initial screening and diagnosis and confirmation should be completed within the first three months of life – as soon as possible after birth – in order to ensure that appropriate amplification and habilitation is underway prior to age six months. JCIH (2007) recommends that screening be accomplished by 1 month, diagnostic testing be accomplished by 3 months and intervention begin by 6 months.
- When hearing loss is diagnosed, routine evaluation should occur ideally at four to six week intervals until full audiograms are obtained, and at three month intervals through age 3 years.
- Assessment at six month intervals from age 4 years is appropriate if progress is satisfactory and if there are no concerns about changes in hearing.
- Immediate evaluation should be undertaken if parent or caretaker concern is expressed or if behavioral observation by parent, therapist or teacher suggests a change in hearing or device function.

More frequent evaluation is appropriate when middle ear disease is chronic or recurrent or when risk factors for progressive hearing loss are present.

Recommended Elements of the Initial Audiological Diagnostic Assessment

(The following section is based on the Joint Committee on Infant Hearing 2007 Position Statement.)

Audiological Evaluation

Comprehensive audiological evaluation of newborns and young infants who fail newborn hearing screening should be performed by experienced pediatric audiologists. The initial audiological test battery to confirm a hearing loss in infants must include electrophysiological measures and, when developmentally appropriate, behavioral methods. Confirmation of an infant's hearing status requires a test battery of audiological test procedures to assess the integrity of the auditory system in each ear, to estimate hearing sensitivity across the speech frequency range, to determine the type of hearing loss, to establish a baseline for further monitoring, and to provide information needed to initiate amplification-device fitting. A comprehensive assessment should be performed for each ear even if only one ear failed the screening test.

Evaluation: Birth to 6 Months of Age

For infants from birth to a developmental age of approximately 6 months, the test battery should include a child and family history, an evaluation of risk factors for congenital hearing loss, and a parental report of the infant's responses to sound. The audiological assessment should include:

- Otoscopic Inspection
- Child and family history.
- ABR testing using air-conducted click and tone burst stimuli and bone-conducted stimuli when indicated. When a hearing loss is detected, frequency-specific ABR testing is needed to determine the degree and configuration of hearing loss in each ear for fitting of amplification devices.
- Click-evoked ABR testing using both condensation and rarefaction single-polarity stimulus, if there are risk indicators (e.g., hyperbilirubinemia or anoxia) for neural hearing loss (auditory neuropathy spectrum disorder -- ANSD) to determine if a cochlear microphonic is present.
- Auditory Steady State Response (ASSR) testing may be used as another means of assessing ear and frequency specific thresholds.
ASSR testing can also be used to assess auditory nerve function when no ABR is present.
- Distortion product or transient evoked otoacoustic emissions (OAE).
- Tympanometry using a 1000-Hz probe tone, and acoustic reflex testing.
- Parent and clinician observation of the infant's auditory behavior as a cross-check in conjunction with electrophysiologic measures. Behavioral observation alone is not adequate for determining whether hearing loss is present in this age group, and it is not adequate alone for the fitting of amplification devices.

Evaluation: 6 to 36 Months of Age

For subsequent testing of infants and toddlers at developmental ages of 6 to 36 months, the confirmatory audiological test battery includes:

- Otoscope inspection
- Child and family history.
- Parental report of auditory and visual behaviors and communication milestones.
- Behavioral audiometry (either visual reinforcement or conditioned-play audiometry, depending on the child's developmental level), including pure-tone audiometry across the frequency range for each ear and speech detection, speech audibility (e.g., using Ling 6-sound test) or speech recognition measures.
- OAE testing. (Otoacoustic emissions)
- Acoustic immittance measures (tympanometry and acoustic reflex thresholds).
- Electrophysiological testing as described above if responses to behavioral audiometry are not reliable.

For children of all ages, the AG Bell Association recommends that all results, questions, and recommendations are discussed with the parents in a culturally sensitive manner and in the family's native language.

Parents should leave the audiology appointment understanding the management plan. They should know when to return for follow up appointments and what their responsibility is in the process (including monitoring full time use of amplification and monitoring what the child hears with the amplification). Parent questionnaires such as the IT-MAIS and ELF may be useful in the monitoring process.

Written reports should be provided and include:

- a. Descriptions of test procedures, conditions of testing, and reliability estimate
- b. A complete audiogram (if available at the initial diagnosis) with symbol key, calibration, and stimuli identified, as well as an explanation of results using tools such as a "Familiar Sounds" audiogram to support parent/teacher counseling
- c. Copies to parents, as well as to primary care provider, Listening and Spoken Language Specialist and other health/education providers as requested in writing by parents
- d. Referral to medical, otolaryngological or other resources (e.g., genetic counseling, social services, psychological counseling, occupational therapy) as appropriate.

Recommended Procedures to Assess Amplification

Identify the hearing instrument, including manufacturer, model, output and response, compression or special feature settings, earmold specifications, and quality of fit. In addition, earmolds need to be well made and acoustically tuned (e.g., tubing, venting, bore size to match the child's hearing loss in order to maximize the child's access to sound). The audiologist should listen to the hearing aids at the start of every test session, and should confirm that parents know how to perform a listening check of hearing aids.

I. Electro-acoustic analysis of hearing aids to document hearing aid performance at the following times:

- a. At initial fitting
- b. At regular intervals (e.g., at follow-up appointments)

- c. Upon return from repairs
- d. If parental concerns arise from behavioral observation or listening check

II. Real-Ear-to-Coupler Measures (RECD's)

- a. Used with prescription method such as DSL or NAL to establish target gain and output
- b. To convert hearing aid performance in 2cc coupler to real ear hearing aid performance
- c. To convert hearing levels in dB HL to ear canal SPL
- d. To assess change in earmold style and fit

III. Cortical evoked response testing to validate hearing aid fittings, where available.

IV. Sound Field Aided Response

- a. To demonstrate the child's response to speech for parent education purposes
- b. To monitor the child's auditory progress
- c. To assess speech perception at soft (e.g., 35 dB HL) and at average conversational levels (e.g., 50 dB HL) in quiet and in the presence of noise to evaluate the effectiveness of amplification technology. Each hearing aid should be evaluated separately and then both tested together.
- d. Assessment of speech audibility using Ling 6 Sound Test at varying distances (e.g., through 6 meters or ~20 feet).
- e. Comparison of Ling results with NAL speech-o-gram if available to evaluate hearing aid fitting.
- f. Functional auditory assessments (e.g., PEACH, LittlEARS) to validate hearing aid fitting.

NOTE: Functional gain measure is an appropriate verification procedure for bone conduction hearing aids and cochlear implants. Verification of amplification requires a real ear to coupler (RECD) measure for children wearing hearing aids.

Recommended Audiological Management for Children with Cochlear Implants

- If adequate access to the full spectrum of acoustic information of spoken language cannot be achieved for an infant or child through conventional amplification, information should be provided to the family regarding cochlear implant technology including benefits and risks as documented in published, peer-reviewed literature along with referral to a pediatric cochlear implant center.
- Upon parental consent the cochlear implant team will review the audiologic information obtained to date and perform further assessments to evaluate the child's suitability for cochlear implantation. Speech perception testing should be included in the pre-CI evaluation and used both in determining candidacy and to compare to post-CI evaluations.
- The LSLS should participate in the cochlear implant candidacy process.
- Following initial mapping of the cochlear implant speech processor(s), re-mapping should be conducted on the schedule recommended by the cochlear implant team given the child's age, device(s) implanted, number of electrodes activated, and additional individual considerations such as a bilateral or bimodal fitting.
- Once the speech processor is programmed to provide optimal access to the speech spectrum, ongoing evaluation at regular intervals is recommended (e.g., at 3 month intervals for the first year). After this period, routine assessment of performance with the cochlear implant continues to be recommended at six to 12 month intervals if progress is satisfactory.

- Sound Field warble tone or narrowband noise thresholds and speech perception testing should be performed whenever the speech processor is programmed and may be helpful along with other troubleshooting techniques whenever problems are suspected. Additional purposes of sound field testing are:
 - a. To demonstrate the child's response to speech for parent education purposes
 - b. To monitor the child's auditory progress
 - c. To assess speech perception at average (e.g., 50 dB HL) and at soft (e.g., 35 dB HL) conversational levels in quiet and in the presence of noise, to evaluate the effectiveness of the cochlear implant, or of each cochlear implant in the case of bilateral fitting.
 - d. Subjective assessment of distance hearing using the Ling 6 Sound Test to demonstrate the range of audibility provided by the technology. In a quiet environment, the child should be able to detect all of the Ling sounds at close distances (e.g., 1 meter or ~3 feet) and at substantial distances (e.g., approximately 12 meters or ~40 feet).
- Immediate evaluation is recommended if parent, caregiver or educator/therapist observe behaviors suggesting a negative change in performance or express concern regarding device function.
- Functional auditory assessments (e.g., PEACH, LittleEARS) to validate hearing aid fitting.

Recommended Audiologic Management Re: FM systems

- a. Every child with hearing loss will benefit from use of an FM system to reduce the negative effects of distance and competing noise.
- b. All technology selected for children should be FM compatible.
- c. Validation and verification should be included in evaluations for children using FM systems. (See American Academy of Audiology Clinical Practice Guidelines for Remote Microphone Hearing Assistance Technologies, 2008). <http://www.audiology.org/resources/documentlibrary/documents/hatguideline.pdf>

RECOMMENDED UNAIDED AND AIDED AUDIOLOGIC PEDIATRIC ASSESSMENT PROTOCOLS BY AGE* OF CHILD

	0-6 Months	6-12 months	12-24 months	24-36 months	Over 36 months
UNAIDED TESTING					
ABR	X	X	X if not performed previously		
Immittance Testing	X 1000 Hz probe tone	X	X	X	X
OAE Testing	X	X	X	X	X
Behavioral testing 250-8000 Hz	X BOA	X VRA	X VRA with transition to CPA	X VRA until child can perform CPA	X CPA
SAT–Ling Sounds	X	X	X		
SRT testing Speech Perception testing at 40 dB above threshold if possible. This test may be useful for			X Body parts, familiar objects	X Body parts, familiar objects. Begin standardized tests.	X Standardized tests

helping families understand what the child is hearing.					
TESTING WITH TECHNOLOGY					
RECD	X	X	X	X	X
Cortical Responses	X	X	X	X	X
SAT - Ling Sounds	X	X	X		
SRT testing			X	X	X
Aided thresholds – 250-8000 Hz	X	X	X	X	X
Aided Speech Perception 50 dBHL –Quiet			X Right, Left, Binaural	X Right, left, Binaural	X Right, Left, Binaural
Aided Speech Perception at 35 dB HL -- Quiet				X Right, Left, Binaural	X Right, Left, Binaural
Aided Speech Perception 50 dBHL- +5 SNL				X Binaural	X Binaural

Note 1: The purpose of all auditory technologies is to deliver the most complete sound possible to the child's brain, where actual "hearing" occurs. The task of technologies is to access, stimulate and develop neural pathways that are the basis for listening, talking, reading and learning.

***Note 2:** The age levels presented represent a child's developmental levels as well as chronological age. A child (or adult) with developmental delays should be assessed with tests appropriate to his/her developmental level, not chronological age.

Note 3: Aided testing refers to whatever technology the child is using. This may be hearing aids, cochlear implants, osseointegrated devices, FM systems and other. Each ear should be tested separately with technology, as well as binaurally.

Abbreviations used in the chart:

"X" means the test should be performed

BOA - Behavioral Observation Audiometry

VRA - Visual Reinforcement Audiometry

CPA - Conditioned Play Audiometry

ABR - Auditory Brainstem Response Testing

SAT - Speech Awareness Threshold

SRT - Speech Recognition Threshold

RECD - Real Ear to Coupler Difference

OAE - Otoacoustic Emissions Testing

RECOMMENDED AUDIOLOGIC SPEECH TEST PROTOCOLS BY AGE* OF THE CHILD

	Birth -6 months	6-12 months	12-18 months	18-24 months	24-36 months	3-5 yrs	6-8 yrs	8+ years
SAT	x	x	x	x				
SRT			x	x	x	x	x	x
ESP		x	x	x				
NU CHIPS				x	x	x		
WIPI						x	x	
PBK						x	x	
NU 6 CNC							x	x
HINT - C or A						x	x	
Baby Bio's							x	x
Az Bio								x

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***Note 2:** The age levels presented represent a child's developmental levels as well as chronological age. A child (or adult) with developmental delays should be assessed with tests appropriate to his/her developmental level, not chronological age.

Note 3: Speech tests are to be presented in unaided and aided conditions. Aided testing refers to whatever technology the child is using. This may be hearing aids, cochlear implants, osseointegrated devices, FM systems and other. Each ear should be tested separately with technology, as well as binaurally.

Abbreviations used in the chart:

“X” means the test should be performed

SAT - Speech Awareness Threshold

SRT - Speech Recognition Threshold

ESP -- Early Speech Perception Test:

<http://www.cid.edu/ProfOutreachIntro/EducationalMaterials.aspx>

NU-CHIPS -- Northwestern University Children’s Perception of Speech:

http://www.advancedbionics.com/content/dam/ab/Global/en_ce/documents/libraries/AssessmentTools/Test%20Reference%20for%20Cochlear%20Implants.pdf

WIPI -- Word Intelligibility by Picture Identification:

<http://www.auditec.com/cgi/Auditec2013Catalog.pdf>

PBK -- Phonetically Balanced Kindergarten Word Test:

<http://www.asha.org/eweb/OLSDynamicPage.aspx?kwr=auditec&webcode=olsresults>

CNC -- Consonant Nucleus Consonant Test: Mackersie, C. L., Boothroyd, A., & Minnear, D. (2001). Evaluation of the Computer-Assisted Speech Perception Test (CASPA). *Journal of the American Academy of Audiology*, 27, 134–144.

Az Bio -- Spahr, A.J., Dorman, M. F., Litvak, L., Gifford, R.H., Loizou, P.C., Loiseau, L.M., & Cook, S. (2012.) Development and Verification of the AzBio Sentence. *Lists Ear & Hearing*, 33, 112-117.

Baby Bio: Spahr, A. J., Dorman, M.F., Litvak, L., Gifford, R. H., Loiseau, L., Oakes, T.,& Cook, S. (2011). A new sentence test for children., *10th European Symposium on Pediatric Cochlear Implantation*. Athens, Greece