AMPLIFICATION PROTOCOL

SEPTEMBER 2024 REVISION

BC Early Hearing Program

A service of BC Children's Hospital
and the Provincial Health Services Authority

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Ryan McCreery, PhD

Alison Beers

Marianne McCormick

Naomi Smith

The BC Early Hearing Program thanks the following colleagues for their review and feedback.

Caroline Hudson

Anna Van Maanen

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OVERVIEW

The British Columbia Early Hearing Program (BCEHP) Amplification Protocol provides direction regarding evaluation, fitting, verification and validation of amplification for infants and young children receiving BCEHP services. The goal of this protocol is to provide BCEHP audiologists with a guide for decision-making regarding hearing aid candidacy, signal processing and feature selection, verification, and outcomes validation for children with permanent hearing loss from birth until their fifth birthday.

The BCEHP Amplification Protocol is based on four key principles:

- The protocol is evidence-based. The content of the protocol is based on the best-available scientific evidence in the field of pediatric amplification whenever possible.
- The provision of amplification should occur soon after the confirmation of hearing loss to minimize the negative developmental consequences associated with periods of reduced audibility.
- The goal of providing hearing aids for infants and young children should be to make speech audible and in cases of unilateral hearing loss, to promote binaural hearing when possible. Candidacy decisions about amplification are based on the degree to which audibility is reduced by the child's hearing loss. Hearing aid verification is designed to confirm that audibility of speech has been optimized with amplification.
- The provision of amplification for infants and young children is a collaborative effort between parents/caregivers, audiologists, otolaryngologists and early intervention providers.

The Amplification Protocol is organized into sections that follow the steps in the process of providing amplification for infants and young children. The protocol outlines the minimum requirements for BCEHP personnel who can provide hearing aid services to children with hearing loss and their families. Data reporting and privacy requirements are outlined. The candidacy criteria for hearing aids for infants and young children are described, followed by the selection considerations for hearing aid characteristics and signal processing. Hearing aid verification processes are described, including verification of advanced signal processing features, if selected. The tools for outcomes validation are also described, including auditory development questionnaires and aided speech recognition procedures. This document is not intended to outline all aspects of amplification provision for infants and young children, but rather is a summary of BCEHP requirements.

Provincial standards and protocols such as this document have been established to ensure that all infants and young children fitted with amplification through the BCEHP consistently receive the same level of high-quality care. This document is the result of work by the BCEHP Amplification Advisory Group, it supersedes the previous BCEHP Amplification Protocol document, and it is in effect until further notice.

1 COMPETENCIES AND FACILITY REQUIREMENTS

1.1 PERSONNEL

AUDIOLOGIST

An audiologist is the professional singularly qualified to select and fit all forms of amplification for children, including hearing aids, cochlear implants, and other hearing assistance technology. An audiologist working with infants and young children must have experience with the assessment and management of hearing loss for this population and the knowledge of procedures and equipment used for pediatric hearing assessment methods, hearing aid selection, and verification procedures.

All procedures funded by the BCEHP will be conducted by audiologists who are active registrants with the College of Health and Care Professionals of British Columbia, registered as a hearing instrument practitioner and/or holding advanced certification in cochlear implant management, as appropriate.

BCEHP provides ongoing training in pediatric audiology and amplification for all audiologists providing BCEHP services. Audiologists who are new to the BCEHP are required to achieve a passing score on the BCEHP Amplification Protocol Exam prior to providing BCEHP amplification services to infants and young children.

AUDIOMETRIC TECHNICIANS

Some tasks may be designated to an audiometric technician at the discretion of and under the supervision of BCEHP audiologists, and in accordance with the bylaws of the College of Health and Care Professionals of British Columbia. Training to meet competency requirements is the responsibility of the health authority. For children who are eligible for BCEHP funding and services, ear impressions must be done by the audiologist and should not be delegated to an audiometric technician.

REGIONAL COORDINATORS

Regional Coordinators or their designee ensure that health authority staff have the opportunity to be trained, are trained appropriately, and ensure that BCEHP protocols are followed by audiologists.

1.2 TEST ENVIRONMENT

ACOUSTICS

Assessments will be done in an audiometric environment that satisfies the current American National Standards Institute (ANSI) standards for hearing aid fitting and verification. Testing in any other environment will not qualify for BCEHP support unless the environment has been specifically and previously approved by the Regional Coordinator or other BCEHP representative.

INFECTION CONTROL

As a minimum requirement, clinicians must adhere to all regulatory and health authority infection prevention and control policies.

1.3 EQUIPMENT, SUPPLIES AND CALIBRATION

Clinics providing BCEHP amplification services must have all of the items listed below:

HARDWARE AND SOFTWARE:

- Otoscope
- Computer with NOAH database and manufacturer software and/or stand-alone programming software
- Up-to-date manufacturer-specific programming software and interfaces
- Hearing aid verification equipment including current software and all accessories (e.g., Audioscan Verifit, Verifit 2, or RM500SL)

CONSUMABLES AND SUPPLIES:

- Otoscope specula
- Probe tubes for the probe microphone verification system
- Foam ear tips for audiological threshold assessment and measurement of real-ear-to-coupler (RECD) differences
- Ear impression supplies and material
- Aural lubricant to ease earmold or probe tube insertion
- Hearing aid batteries
- Pediatric ear hooks for hearing aids, and any other parts which may commonly break down or require replacement (e.g., battery doors, dust filters)

CALIBRATION

Equipment must be installed by a qualified/certified audiometric instrument specialist, authorized and trained by the equipment manufacturer, and calibrated to ANSI specification standards (ANSI/ASA S3.6-2010) for Audiometers. All equipment must be maintained in accordance with the calibration requirements outlined by the College of Health and Care Professionals of British Columbia.

2 DATA AND DOCUMENTATION

All clinical data and documentation must be maintained in accordance with the requirements outlined by the College of Health and Care Professionals of British Columbia.

2.1 DATA

All clinical visit dates, audiological thresholds and assessment results, medical clearance date, hearing aid requests, ordering and fitting information are documented in the child's BC Early Hearing Surveillance Tool (BEST) record. Refer to the BEST site or contact the BCEHP Provincial Office for further information.

2.2 DOCUMENTATION

The required documentation listed in this section must be complete and current in the child's clinical file and/or BEST record and must be provided to the BCEHP upon request for audit or other purposes. There may be additional information required by the health authority or the College of Health and Care Professionals of British Columbia, which must also be maintained by the audiologist as mandated.

DOCUMENTATION REQUIREMENTS

- Service delivery date
- Client name, date of birth and BCEHP number
- Make, model and serial number of hearing device(s)
- Indication of right or left ear for each hearing device fit
- Earmold and tubing type, if applicable
- Frequency-specific and ear-specific thresholds, and middle ear function and otoacoustic emission results as appropriate and according to BCEHP assessment requirements
- Medical clearance date and physician signature for fitting of hearing equipment
- Real-ear-to-coupler difference (RECD) values and measurement printout, if applicable
- Prescriptive method used
- Hearing instrument verification data
- Current hearing instrument settings (saved electronically or printed in the patient chart)
- A signed copy of the Hearing Equipment Agreement form
- Documentation of patient outcomes with amplification (e.g., functional assessment tool completed by parent or early interventionist, subjective feedback from the family or interventionist, data-logging hours)

FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY

All personal information collected by BCEHP is gathered under the authority of the province's *Freedom of Information and Protection of Privacy Act*, section 26. The information will be used to determine eligibility for funding and to confirm accuracy of invoicing and track intervention services. Information about individual children may be shared with other professionals who provide services to families as part of the program. These professionals may include other hearing clinics, hospitals, health units, child development centers, early intervention programs or education centers.

3 AMPLIFICATION CANDIDACY AND AUDIOLOGICAL DATA

3.1 DEGREE OF HEARING LOSS AND UNAIDED SPEECH INTELLIGIBILITY INDEX (SII) VALUE

Children with permanent hearing loss resulting in an unaided speech intelligibility index (SII) less than or equal to 80 in one or both ears (based on the Audioscan Verifit and using an input level of average speech at 65 dB SPL) should be considered candidates for amplification (McCreery et al. 2020). Binaural amplification will be recommended for all infants with confirmed permanent hearing loss when both ears meet the SII fitting criteria. For any frequencies where hearing is normal by ABR (i.e., ≤25 dBeHL), a threshold value of 10 dB HL will be entered into the Verifit system to calculate the unaided SII value.

3.2 MEDICAL CLEARANCE

BCEHP requires that medical clearance from an otolaryngologist be obtained prior to fitting hearing aids. The College of Health and Care Professionals of British Columbia does not require medical authorization for public health audiologists to take earmold impressions. A copy of the signed medical clearance form must be kept in the child's clinical file.

3.3 AGE AT FITTING

The BCEHP endorses the provision and verification of amplification by three months corrected age regardless of whether hearing loss is bilateral or unilateral.

Fitting of amplification to infants less than three months of age is not generally recommended. Although early provision of amplification is associated with improved communication, infants less than three months of age have limited waking hours during the day. There is limited evidence that fitting amplification prior to three months of age produces better language outcomes than fitting at three months of age or later. Infants experience significant ear canal growth during this period of time, and the potential for acoustic feedback and need for frequent earmold replacement may adversely impact a family's early experience with amplification.

See Section 7.1 for the recommended fitting timeline of bone conduction devices.

3.4 AUDIOMETRIC THRESHOLDS

Infants should be fitted to the best estimate of the audiogram based on frequency-specific auditory brainstem response (ABR) thresholds if behavioural thresholds are not yet available.

The greater the number of thresholds available, the greater the accuracy of the fitting, which should result in better aided audibility and comfort for the child. Amplification can be fitted if only 500 Hz and 2000 Hz thresholds are known for a given ear until such time as additional thresholds are established. ABR threshold information will be reported in eHL (estimated Hearing Level as per the BCEHP ABR Protocol). The eHL levels will be used in the hearing aid fitting protocol (e.g., DSL™ Child). For any ABR thresholds equivalent to BCEHP normal hearing levels (i.e., ≤25 dB eHL), 10 dB eHL should be entered as the threshold to generate estimates of unaided audibility for hearing aid candidacy.

Where there is no clear response present by ABR at severe-to-profound hearing loss levels bilaterally and auditory neuropathy spectrum disorder (ANSD) has been ruled out, amplification should be considered and is required as part of cochlear implant candidacy assessment for children with bilateral hearing loss (see Section 4.1 for considerations for children with severe-to-profound unilateral hearing loss). In these cases, the frequency-specific dB eHL threshold used for hearing aid fitting should be 5 dB above the highest intensity level where no response was observed by ABR. Consult the BCEHP ABR protocol for details regarding threshold estimation by ABR for infants and young children.

Sedated ABR is recommended to determine ear- and frequency-specific thresholds if reliable behavioural thresholds have not been established after two attempts at behavioral audiometry, and if the audiologist believes that reliable thresholds are unlikely to be obtained within three months. Behavioural responses to soundfield stimuli are not ear-specific and cannot be used as the basis for hearing aid fitting and adjustment.

3.5 REAL-EAR-TO-COUPLER DIFFERENCE (RECD)

RECD must be measured unless contraindicated. Contraindications include drainage from the ear canal, occluding cerumen in the ear canal, or active otitis externa. There may also be cases where RECD measurement is not possible without sedation due to limited cooperation from the child. If individually measured RECDs cannot be obtained, average values based on the child's age in months may be used. Age-appropriate and transducer-specific RECD values are available in the current DSL™ V.5 Audioscan Verifit, Verifit 2, or RM500SL Software. The variability around average RECD values can be ±12 dB (Bagatto et al., 2002), which can lead to fitting inaccuracies of the same magnitude.

RECD measurements at the time of the ABR assessment using an insert foam tip will provide the most accurate estimate of the unaided SII and quantify the impact of RECD on ABR thresholds. However, practice patterns at different clinics may not allow for individual measurement of the RECD at the time of the ABR assessment. If the RECD cannot be measured at that time, the unaided SII can be estimated based on the average RECD for the child's age. The RECD can then be measured at the hearing aid fitting using an insert foam tip or the child's earmold. If the child's middle ear status is within normal limits for both ears and there is no obvious visual difference in structure between the ears, it is not necessary to measure an RECD for each ear. Average RECD values should be avoided in cases where there is an obvious physical difference (e.g., tympanostomy tube, tympanic membrane perforation, ear canal stenosis, surgical ear-canal modification) between the child's ear and a normal ear-canal size for their age.

The RECD is applied to the transforms for dB SPL threshold estimation (assessment), target generation (hearing aid verification), and hearing aid output (hearing aid verification). There are differences between an RECD coupling with a foam insert tip and an RECD for an insert coupled to a child's earmold related primarily to the variation in tubing length of individual earmolds. Both foam tip and earmold RECD produce reasonable estimates of ear-canal dB SPL for simulated real-ear measures (Gustafon, Pittman, & Fanning, 2013). If the assessment coupling is a foam insert tip, the recommended RECD coupling for hearing aid verification is a foam insert tip. If the assessment coupling is the child's earmold, the RECD coupling should be with the child's earmold.

4 AMPLIFICATION FOR DIFFERENT TYPES OF HEARING LOSS

4.1 UNILATERAL HEARING LOSS

The available research on the benefits of fitting hearing aids for infants and young children with unilateral hearing loss (UHL) is limited. Children with UHL are at greater risk for speech and language delays and academic difficulties at school-age than peers with normal hearing in both ears, but predicting which children with UHL will experience negative outcomes is challenging due to the heterogeneity of this group. For the purposes of hearing aid candidacy, children with UHL can be separated into two groups based on the audibility levels in the ear with hearing loss:

Aidable Unilateral Hearing Loss: Normal hearing in one ear and an unaided SII between 5 and 80 in the ear with hearing loss (based on a 65 dB SPL speech input).

Note that children with unaided SII = 0-4 will be considered candidates for amplification in cases where aided SII is greater than or equal to 50.

Children with aidable UHL should be considered candidates for monaural amplification to help promote binaural access and the development of auditory brainstem pathways that support binaural hearing.

Unaidable Unilateral Hearing Loss (i.e., severe-to-profound UHL): Normal hearing in one ear and in the other, an unaided SII < 5 and an aided SII < 50 with an appropriately fitted hearing aid (using a 65 dB SPL speech input).

Children with unaidable UHL are unlikely to receive benefit from amplification in the ear with hearing loss due to distortion and potential for cross-over of amplified sound to the ear with normal hearing. The potential for cross-over increases for children with hearing thresholds > 75 dB HL based on conservative estimates of inter-aural attenuation. Consult Section 5 Fitting Uncertainty for additional guidance when amplification candidacy in unclear.

There is currently limited evidence regarding the potential benefits and limitations of a trial with a hearing aid for children with unaidable UHL prior to cochlear implantation. Promotion of auditory stimulation and preservation of neural function of the impaired ear for children with unaidable UHL should be weighed against the potential for limited device use and binaural interference. The BCEHP does not currently provide amplification for children with unaidable UHL who may be candidates for cochlear implantation.

4.2 ACQUIRED CONDUCTIVE HEARING LOSS

Children with acquired conductive hearing loss exceeding six months in duration should be considered candidates for hearing aids when medical management is not available and medical clearance has been obtained. Amplification is not an alternative to medical management, but rather an option when medical management is not feasible. The following requirements must be documented for hearing aid candidacy for acquired conductive hearing loss:

- Medical clearance from a managing otolaryngologist for fitting with amplification
- Confirmation from a physician that medical management is not an option in the near future
- Unaided SII value that is less than or equal to 80

Most children with chronic conductive hearing loss due to middle ear fluid will have largely stable air conduction thresholds over time in the absence of medical management (Gravel & Wallace, 2000). For this reason, conventional behind-the-ear (BTE) hearing devices are the instruments of choice for this population. If, however, there is evidence of air conduction threshold fluctuation meeting the criteria of ≥ 10 dB shift at two or more frequencies over three consecutive tests within a 6 to 12 month period, and bone conduction thresholds are near-normal, then fitting with a bone conduction device on a softband is supported.

4.3 AUDITORY NEUROPATHY SPECTRUM DISORDER (ANSD)

Children with ANSD have a wide range of outcomes when fitted with hearing aids, even when hearing aids are fitted appropriately and worn consistently. The inconsistency in hearing aid benefit with ANSD has prevented the development of a consensus on a single appropriate management strategy for infants and children identified with the disorder (e.g., Berlin, Morlet, & Hood, 2003; Berlin, Hood, Morlet, Li, Brashears, Tedesco, et al., 2003; Walker et al. 2015). Predictors of hearing aid benefit for children with ANSD with aidable hearing levels are not clear from the literature.

Decisions about whether to fit amplification for an infant identified with ANSD begins with a review of the audiological assessment including ABR waveforms and thresholds (see BCEHP ABR Protocol for diagnostic requirements and interpretation). Infants with definite ANSD and significantly elevated or absent ABR thresholds at high levels should be fitted only once reliable behavioural audiological thresholds have been established. Amplification for infants with a component of ANSD may be considered in cases where ABR thresholds can be established with good reliability despite atypical waveform morphology or response characteristics. In these cases, ABR results will be reviewed by the BCEHP ABR Support team and a recommendation to fit will be based on consultation between the ABR Support team, the BCEHP Amplification Support team, the community audiologist and the family. Decisions about amplification in these cases will be made by weighing the risks associated with fitting versus the risks of deferring amplification until behavioural testing is completed and will be made on a case-by-case basis due to the limited research evidence base for this approach.

For a child with ANSD where behavioural audiological thresholds cannot be obtained in a timely manner, the BCEHP is currently piloting the use of testing cortical auditory potentials to help guide decisions regarding amplification and evaluating predictors of behavioural thresholds from ABR results to help reduce the age of hearing aid fitting in this population.

5 FITTING UNCERTAINTY

The BCEHP Amplification Protocol is intended to provide consistent and equitable access to hearing aids and early intervention services for infants and young children with permanent hearing loss across the province using evidence-based candidacy guidelines. Inconsistency in provision of hearing aids increases when audiologists are uncertain about a child's eligibility. Uncertainty may occur in cases where there are concerns about the quality or quantity of diagnostic audiological data that are used to generate audibility estimates. Uncertainty may also occur when the child's unaided SII is very close to the eligibility criterion level (≤ 80).

Uncertainty around audiological data used to generate estimates of unaided audibility can be resolved by following consistent diagnostic approaches that can help to quantify the frequency range and degree of hearing loss. Some children have syndromes or craniofacial conditions associated with conductive hearing loss, and there may be uncertainty about whether a loss is permanent due to limited bone conduction data in some cases.

In cases of fitting uncertainty, the following tests or techniques can help a clinician decide on the appropriate course of action:

- Use distortion-product otoacoustic emissions to determine the likelihood of hearing loss at high-frequencies not tested by auditory brainstem response (ABR) or behavioral audiometry. Otoacoustic emissions cannot be used to estimate specific thresholds, but the absence of emissions may provide greater resolution of the extent of hearing loss in the high frequencies. This may differentiate isolated hearing loss at a single frequency from high-frequency hearing losses that extend over a larger frequency range.
- Establish no-response levels for ABR by testing below the minimum response levels (25 dBeHL) at 2000 Hz and/or 4000 Hz to better differentiate slight or mild hearing levels from normal hearing levels.
- For instances where hearing loss is isolated to 4000 Hz, obtaining bone conduction thresholds by ABR assessment can provide valuable information to support the presence of permanent hearing loss.
- Measure the child's own RECD using an insert + foam tip at the time of the diagnostic evaluation or soon thereafter to quantify the influence of ear-canal acoustics on thresholds.
- Compare the child's unaided SII to a simulation of the child's aided SII using simulated real-ear measures with an average speech input at 65dB. Amplification should not be considered unless the measured aided SII is at least 10 points higher than the unaided SII. Aided and unaided long-term average speech spectra on verification equipment can be compared to determine if specific frequency regions are less audible in the aided condition than in the unaided condition. Poorer aided than unaided audibility most frequently occurs when thresholds at and above 4000 Hz are normal and the bandwidth of hearing aids is limited.
- In cases where the initial ABR assessment was completed at 4-6 weeks of age, re-measure ABR thresholds at 3 months of age to re-evaluate SII and amplification candidacy.
- Complete regular behavioral assessments as soon as the child is developmentally ready to gather additional information about the child's degree and configuration of hearing loss.

Uncertainty about amplification candidacy can occur when a child may not meet audibility-based candidacy criteria for mild bilateral or unilateral hearing loss but may have other factors that create concern for hearing or communication development. The BCEHP Amplification Support team should be consulted to get timely input on cases and avoid delays in the provision of amplification due to uncertainty about candidacy.

If the audiologist decides not to recommend amplification initially, decisions about hearing aid candidacy can be revisited as more audiological information becomes available. Intervention services are available for children with permanent hearing loss when unaided SII ≤ 80 in at least one ear even if amplification is not fitted (e.g., in cases of severe-to-profound unilateral hearing loss).

FITTING UNCERTAINTY WHEN SII > 80

Children with unaided SII ≤ 80 are at risk for delays in language development. Infants and young children with unaided SII levels > 80 are not considered candidates for amplification because these levels of audibility were associated with language abilities similar to children with normal hearing (McCreery et al. 2020) and because the improvements in aided audibility are constrained with the upper limit of the SII at 100. Additionally, children with unaided SII > 80 are likely to have frequency regions of normal hearing that could result in poorer audibility with amplification, particularly at frequencies > 2000 Hz where occlusion from the earmold can limit audibility and hearing-aid bandwidth may be limited. Clinicians can contact BCEHP Amplification Support for guidance in cases where the unaided SII exceeds 80.

Note that unaided SII values measured with speech input levels below 65 dB SPL are not used to determine amplification candidacy; children with normal hearing thresholds may have unaided SII values < 80 for soft speech.

FITTING UNCERTAINTY WITH UHL SII 0-4

Uncertainty in hearing aid candidacy for children with unilateral hearing loss most often occurs when the unaided SII = 0-4 and the simulated aided SII values for the impaired ear are around the criterion level of 50. The aided audibility criterion for unilateral hearing losses has not yet been validated in the same manner as the upper unaided SII limit for bilateral hearing loss candidacy; however, there are several considerations that can be helpful for resolving uncertainty around candidacy for unilateral hearing loss:

- Cross-over of an amplified signal from the poorer ear to the ear with normal hearing may contribute to binaural interference. Binaural interference occurs when performance is poorer with binaural input than with monoaural input. There are three potential signals that can occur when attempting to provide amplification for children with UHL > 70 dB HL: 1) the unprocessed sound received by the typical hearing ear, 2) the crossover of amplified signal from either the air or bone conduction device to the typical hearing ear, and 3) audible amplified signal at the impaired ear via air or bone conduction. Because children in the age range for the BCEHP are often too young to measure binaural interference with amplification directly, conservative estimates of crossover based on the threshold levels in the poorer ear and published interaural attenuation values should be applied (Munro & Contractor, 2010). Children with air conduction thresholds > 75 dB HL are likely to experience audible crossover of the amplified signal to the better ear. Amplification may result in binaural interference even if the aided SII is 50 or greater.
- The aided SII is not currently formulated to reflect changes in audibility that can occur with frequency lowering signal processing. This means that the aided SII could underestimate audibility in cases where frequency lowering is used. However, the differences in audibility that are observed with frequency lowering are often small (i.e. McCreery et al. 2015) and should not be a factor in interpreting borderline aided audibility values for children with unilateral hearing losses.
- Consider the future impact of ear canal growth on the feasibility of maintaining a beneficial aided SII without cross-over. If a high power hearing instrument must be set to near-maximum values to reach the aided SII criterion level of 50 for a young infant, then it is unlikely that this level of benefit can be maintained as the ear canal grows. Likewise, as the ear canal grows, the child's air conduction thresholds in dB HL will decrease and the required hearing aid output may result in cross-over.

6 CRITERIA FOR HEARING INSTRUMENT SELECTION

Hearing instruments chosen for inclusion in the BCEHP have a number of features that are mandatory. Following is a list of required hearing instrument features for hearing aid fittings funded by the BCEHP.

6.1 NON-ELECTROACOUSTIC CHARACTERISTICS

BEHIND-THE-EAR (BTE) HEARING INSTRUMENTS

Behind-the-ear (BTE) hearing aids are recommended for all children unless the child has insufficient pinna or ear canal anatomy to retain a BTE hearing aid coupled to an earmold or if a BTE hearing aid is medically contraindicated. For children with permanent hearing loss who cannot use a BTE hearing aid, a single bone conduction device on a softband is recommended. Refer to Section 7.1 for additional information regarding fitting of bone conduction devices.

BTEs are mandated due to:

- Rapid growth of a child's ear necessitates the need for frequent remakes of the earmold.
- Greater fitting range, lower cost and better durability compared to custom in-the-ear hearing aids and bone conduction devices.
- The option to use a loaner BTE device coupled to a child's personal earmold.
- Custom products are less durable and require more frequent repairs than BTE hearing aids.
- Custom products are more prone to feedback due to the close proximity of the microphone to the receiver.

HEARING ASSISTANCE TECHNOLOGY COMPATIBILITY AND CONNECTIVITY

Infants and young children may need to access hearing assistance technology (HAT), including remote-microphone frequency- or digital-modulation (RM-HAT) systems. Therefore, hearing aids that provide options for connectivity to RM-HAT systems and other devices that are needed for communication are preferred over devices that do not have these options. The evidence that RM-HAT systems can provide benefits to school age children in classroom settings is well-established (Crandell, 1993). However, the benefits of RM-HAT for infants and young children in different listening situations have yet to be documented in the literature. The BCEHP does not provide funding for RM-HAT systems at the present time, but choosing hearing aids that are compatible with RM-HAT will ensure that the hearing aids can be used with RM-HAT, if needed.

TAMPER RESISTANT BATTERY DOORS AND TONE HOOKS

Infants and young children are at higher risk for choking on small objects. Batteries are toxic when swallowed. Tamper-resistant battery compartments and tone hooks should be a standard feature for all BCEHP hearing aid fittings.

PROGRAM SWITCH AND/OR VOLUME CONTROL LOCK OR DEACTIVATION

If a child's hearing aid is equipped with a volume control or program switch, the feature should be de-activated in the programming software to avoid unintended alterations to the output of the hearing aid or inadvertent program changes.

PEDIATRIC-SIZED TONE HOOK

In some cases, manufacturers will send adult-sized unfiltered tone hooks when hearing instruments are ordered. A pediatric tone hook will allow the BTE to be retained on the infant's ear. Tone hooks should be replaced with larger options once the child's pinna outgrows the pediatric tone hook.

TONE HOOK FILTER

In most cases, pediatric tone hooks provided by manufacturers will include an appropriate damper. Otherwise, a filtered tone hook can be used to smooth the resonant peaks of the hearing aid output. A filtered tone hook may not be desired if the audiologist wishes to maintain resonant peaks in the hearing aid output, particularly in situations where the damper may limit speech audibility at maximum gain settings.

WATER-RESISTANCE

An instrument that is water resistant is highly desirable for children. Families and children should be counselled about the extent of water-resistance for their hearing aid, as the degree of resistance varies considerably within models of the same manufacturer and across manufacturers.

RETENTION DEVICES

Retention devices assist in keeping the hearing instruments in place as well as assisting in loss prevention (e.g., Critter Clips, Ear Gear, wig tape) and are encouraged for use with infants and young children.

REMOTE CONTROL AND/OR SMART PHONE APP

Some hearing aids have a remote control or smartphone app that can be used to control the hearing aids. These applications should be considered for parental control of multi-memories and/or volume control.

6.2 ELECTROACOUSTIC CHARACTERISTICS

Amplification is chosen based on gain and output targets individually calculated from the infant's hearing thresholds and ear-canal acoustics. Therefore, it is not possible to specify electroacoustic characteristics that will match targets for all individual infants. The role of BCEHP is to establish general guidelines for target generation and hearing instrument selection. The role of the audiologist is to select amplification that will meet the prescribed targets and can be adapted over time to meet the child's needs as the ear canal grows and if their hearing changes.

FLEXIBILITY IN FITTING RANGE AND AUDIBLE BANDWIDTH

The hearing aid should have sufficient flexibility in frequency/output shaping to provide audibility across a wide input level and frequency range and to allow for increased output requirements due to ear canal growth and possible progression of hearing loss. The aided SII is most heavily weighted for frequencies from 500 Hz – 4000 Hz. However, providing a signal with a broad bandwidth should be a goal for pediatric hearing aid fittings even if the hearing aid fitting is within the normative range for audibility (Stelmachowicz et al. 2004). The audible bandwidth of the hearing aid can be measured as the maximum audible output frequency (MAOF) range, which is the range of frequencies between where the average and peak of the long-term average speech spectrum intersects the audiogram in the high frequencies (see McCreery et al. 2013 and Scollie et al. 2016 for further discussion). An audible bandwidth > 6000 Hz is desirable and may be possible with current devices for children with mild high-frequency hearing losses (Van Eeckhoutte et al. 2020).

ABILITY TO DISABLE EXTRA PROGRAMS AND/OR TELECOIL

The hearing aid default/base program should allow for the RM-HAT + Mic setting to engage when the hearing aid is coupled to an RM-HAT receiver.

ABILITY TO DISABLE ADVANCED FEATURES

Some signal processing features of hearing aids may not be designed for infants and young children or may need to be activated in specific programs or at a specific age. Devices that allow activation or deactivation of advanced features in the programming software are essential. For further information on activation and verification of advanced features, see Section 10.

TYPE OF SIGNAL PROCESSING

Wide-dynamic-range compression is widely available for nearly all hearing aid models. The amount of amplitude compression should be determined by matching individual prescriptive targets across the input levels associated with soft, average, and loud speech during hearing aid verification. For further information regarding verification of air conduction hearing aids, see Section 8.2.

7 BONE CONDUCTION DEVICES, BIMODAL STIMULATION AND CONTRALATERAL ROUTING OF SOUND (CROS)

7.1 BONE CONDUCTION DEVICES

Children with unilateral or bilateral conductive hearing loss who cannot be fitted with BTE hearing aids should be considered candidates for bone conduction devices. Children with mixed hearing losses who have contraindication(s) for BTE hearing aids may also be candidates for bone conduction devices if the average of their bone-conduction pure tone average (PTA) is < 45 dB HL.

AGE AT FITTING FOR BILATERAL HEARING LOSS

For infants with bilateral hearing loss meeting eligibility in both ears for fitting with a bone conduction device (e.g., bilateral ear canal atresia), sequential fitting of these devices is recommended. It is recommended that a single bone conduction device is fit by three months corrected age. This device may be worn on the forehead if needed in order to minimize feedback. A second bone conduction device should only be fit once the child can sit without assistance and the bone conduction devices can be mastoid-worn bilaterally.

AGE AT FITTING FOR UNILATERAL HEARING LOSS

For infants with unilateral hearing loss meeting eligibility for fitting with a bone conduction device, fitting is recommended as soon as the child can sit without assistance. Because bone conduction devices for infants with unilateral hearing loss must be worn on the correct mastoid, the benefit is likely to be limited when infants are supine and the processor is obstructed.

7.2 BIMODAL STIMULATION

Bimodal stimulation is electrical stimulation from a cochlear implant in one ear and acoustic stimulation in the other ear from a hearing aid. Evidence suggests that children and adults perform better on speech recognition and localization tasks with bimodal stimulation compared to unilateral stimulation with either a hearing aid or a cochlear implant alone (Ching et al. 2006). Children who receive a unilateral cochlear implant and have residual hearing in the opposite ear should be considered candidates to continue to use amplification in the non-implanted ear. The process of providing amplification in a bimodal configuration should be based on matching prescriptive targets and maximizing audibility for speech, using the same verification and validation methods as children with other configurations of amplification.

7.3 CONTRALATERAL ROUTING OF SOUND

Contralateral routing of sound (CROS) devices transmit sound from the ear with hearing loss to the normal ear to improve access to sounds above 1.5 kHz that are reduced due to the head-shadow effect. Sound can be transmitted via air conduction or bone conduction.

Air-conduction CROS devices have not been evaluated in infants and young children and the benefits of CROS devices in older children and adults are typically situational (talker of interest on the poorer hearing side). For these reasons, CROS devices are not currently recommended for infants and children in the age range served by the BCEHP.

Bone conduction devices used as a CROS for severe or profound UHL have some evidence to suggest that they can minimize the loss of audibility in the high frequencies related to the head-shadow effect, but they do not restore binaural hearing. Based on the high cost of these devices and limited potential benefits of bone conduction devices for severe or profound UHL, the BCEHP will not provide bone conduction devices for severe or profound UHL at the present time.

8 VERIFICATION OF AIR CONDUCTION HEARING AIDS

8.1 PRESCRIPTIVE METHOD RATIONALE

A systematic, evidence-based prescriptive process must be used that takes into account the individual acoustic properties of each infant's ears. The prescription should ensure speech audibility at a comfortable level over as broad a frequency range as possible, and should ensure that sounds do not exceed an acceptable loudness level. It should incorporate age-dependent variables such as ear canal size, where necessary. The Desired Sensation Level Method (DSL™ Child) is the approach of choice for BCEHP.

8.2 VERIFICATION OF HEARING AID OUTPUT

To ensure audibility for speech and other environmental sounds, the output of the hearing aid must be measured in the child's ear canal (*in situ* verification) or in a hearing aid coupler with an appropriate RECD simulated real-ear measurement (SREM).

IN SITU VERIFICATION

The most accurate method of hearing aid verification for children is measuring the output of the hearing aid in the child's ear canal using a probe microphone system, known as *in situ* verification. Prior to *in situ* measurement, the child's RECD should be measured to facilitate an accurate conversion of dB HL thresholds to dB SPL for prescriptive target generation (see Section 3.5 for details).

The probe tube should be placed either 3 mm past the earmold sound bore or 10 mm past the opening of the ear canal. The hearing aid and earmold are inserted into the child's ear canal while verification stimuli are presented from a speaker in front of the child. Verification of maximum power output (MPO) may be frightening or uncomfortable for some children when conducted using *in situ* verification. Children must be old enough to sit unassisted and control their head during *in situ* verification.

SIMULATED REAL-EAR MEASUREMENT (SREM) VERIFICATION

In cases where a child is not able to sit without support or cannot cooperate for multiple *in situ* measurements, SREM is an alternative verification method. In SREM, hearing aid measurements are completed in a test box with the hearing aid attached to a coupler. The RECD is applied to the hearing aid measurements in the coupler to simulate the response of the hearing aid in the child's ear based on their ear canal acoustics. As noted in Section 3.5, the RECD coupling (foam insert tip or earmold) should be the same for hearing assessment and hearing aid verification.

HEARING AID VERIFICATION STIMULI AND INPUT LEVELS

The goal of hearing aid verification is to assess audibility for speech and ensure that the maximum output of the hearing aid does not exceed prescribed levels. To achieve this goal, the output of each hearing aid should be assessed using a calibrated speech stimulus and a standard pure-tone sweep for maximum power output (MPO). The recommended input levels for hearing aid verification are:

- Soft speech (55 dB SPL)
- Average speech (65 dB SPL)
- Loud speech (75 dB SPL)
- Maximum power output (85 or 90 dB SPL)

8.3 HEARING AID VERIFICATION OUTCOMES

The hearing aid fitting should be matched to prescriptive targets at each of these input levels. It is usually possible to meet targets within 3 dB and efforts should be made to match prescriptive targets as closely as possible. If the hearing aid fitting deviates from prescriptive targets by more than 5 dB, documentation should be provided as to the reason for the deviation.

The speech intelligibility index (SII) should be recorded for average speech input levels and compared to the normative SII range from Bagatto and colleagues (2016). A child's aided SII should fall within the normative range for their degree of hearing loss (PTA). Documentation should be provided in cases where a child's fitting falls outside of the normative range.

8.4 ROOT-MEAN-SQUARE ERROR (RMSE)

The ability to improve audibility for speech with a hearing aid decreases as a child's degree of hearing loss increases. This is due to reductions in the dynamic range of the auditory system that occur with permanent hearing loss and hearing aid output limitations. This is evident in the negative slope of the normative data for the aided SII as pure-tone-average increases, which means that there is no single aided SII value that is optimal or attainable for all children with hearing loss. For this reason, the aided SII on its own cannot be an indicator of hearing aid fitting quality for children (McCreery et al. 2013).

The root-mean-square error (RMSe) is a measure of the absolute difference (geometric mean) of the difference between the hearing aid output and prescriptive targets at 500, 1000, 2000, and 4000 Hz. The RMSe can be calculated manually by taking the average of the unsigned (positive/negative) differences between prescriptive target and output or by accessing the RMSe values calculated in the Verifit 2. Previous studies have suggested more consistent audibility and better outcomes for children with an RMSe < 5 dB (McCreery et al. 2013, McCreery et al. 2015). However, recent research suggests that an RMSe < 3 dB can further improve audibility and language outcomes for children with hearing aids (Wiseman et al. 2022). The range of the prescriptive targets on the Verifit is +/- 3 dB. Deviations from prescriptive target may occur because of device bandwidth limitations, severe degrees of hearing loss, or acoustic feedback, but these deviations should be documented to ensure that the reason for deviations from targets were recognized by the fitting audiologist and are not able to be improved.

9 VERIFICATION OF BONE CONDUCTION HEARING DEVICES (BCHD)

There is limited research in the area of bone conduction hearing devices (BCHD) for infants and young children and therefore a lack of standard protocols or guidelines. In 2021, Bagatto et al. developed the Clinical Consensus Document for Fitting Non-Surgical Transcutaneous Bone Conduction Hearing Devices to Children. The BC Early Hearing Program endorses adhering to these guidelines and encourages clinicians to consult this document for more information. Guidelines are summarized below.

FEATURES OF BONE CONDUCTION HEARING DEVICES AND FITTING CONSIDERATIONS

The following is a list of recommendations for fitting BCHDs to children under the age of five years:

- An elastic band coupling is recommended (e.g., Softband). The band should be adjusted on the child's head so that two adult fingers can slip underneath it comfortably (Hodgetts, Scollie and Swain 2006). It should not leave marks on the head when removed.
- The device should be positioned over the mastoid process on either side in the case of a bilateral conductive hearing loss and on the hearing-impaired side in the case of a unilateral hearing loss. It can also be temporarily placed on the high temporal bone or on the forehead if acoustic feedback is an issue due to the child's positioning (i.e., in a car seat).
- High maximum force output (MFO) level devices are recommended, when available. The use of high MFO devices will result in improved audibility and less saturation and artefact (Bianchi et al. 2019).
- It is recommended that the device can be connected to a skull simulator (directly or via an adaptor) for verification in the future.
- The device should have the capability to perform *in situ* thresholds (thresholds obtained using the device). *In situ* BC thresholds account for skin transmission loss, device and coupling differences. *In situ* BC thresholds are strongly recommended as soon as they can be obtained. They provide data to the hearing aid software for prescriptive programming purposes, however they are not a form of verification.
- Like with air conduction hearing devices, tamper-proofing, remote microphone compatibility, data-logging capabilities, feedback management algorithms and the ability to disable volume control, program buttons and advanced features, is recommended. The microphones should be in omni-directional mode.

VERIFICATION OF BONE CONDUCTION HEARING DEVICES

Skull simulators can be used to objectively measure and verify the force output of bone conduction hearing devices (Hodgetts & Scollie, 2017). They can only be used for verification and estimates of audibility in percutaneous (surgical) fittings.

For children under the age of five years, where non-surgical devices are the standard of care, behavioural testing is the only available option for verification. A child's behavioural responses to pure-tones and speech can be measured with the bone conduction device in the sound booth.

- The signals should be presented at 90° azimuth towards the BCHD. In the case of a unilateral hearing loss, it is recommended that a masking noise be presented via an insert earphone to the unaffected ear.
- Optimal aided detection of pure tones or speech sounds in the sound field should occur at levels between 20 to 30 dB HL.
- Thresholds using the Ling 6 sounds can be measured to demonstrate an improvement in audibility for speech sounds.

Note that aided soundfield testing with pure tones has numerous limitations related to how hearing aids and bone conduction devices process these signals (ASHA, 2000). The presence of amplitude compression in bone conduction hearing aids means that the amount of gain present at soft levels is much greater than the gain provided to speech signals. Aided detection in soundfield is not the same as verification and should not be used to make inferences about speech audibility, or to guide programming adjustments.

For children who cannot be assessed using behavioural test methods, there is no verification procedure available and the manufacturer's recommended device settings should be used. Clinicians and families can be reassured that even for adults using percutaneous devices, loudness discomfort levels tend to be higher than the maximum force output (MFO) levels (dB FL) of these devices (Hodgetts et al, 2011). Given that skin attenuation reduces the MFO in transcutaneous fittings (Van Barneveld et al., 2018), there is likely little risk of loudness discomfort. It is prudent, however, to counsel parents to be aware of signs of loudness discomfort and to report back to the clinician should there be concerns.

If a skull simulator is available, it can be helpful to run force output curves in the hearing aid analyzer at user settings. These can be kept on file for future comparison to ensure that the device is functioning. However, adjustments should not be made based on these measurements.

10 ADVANCED SIGNAL PROCESSING FEATURES: ACTIVATION AND VERIFICATION

Hearing aids have advanced signal processing algorithms and features. Many are designed to optimize adult listening preferences and perception and have not been extensively evaluated for children. Unless otherwise noted, advanced features should be activated for speech-based hearing aid verification so that the effects on audibility can be measured. The use of manufacturers' "verification mode" that disables advanced features should only be used during verification of the maximum power output (MPO).

10.1 FEEDBACK MANAGEMENT / FEEDBACK SUPPRESSION

Feedback can be a significant problem for children who wear hearing aids, due to ear canal growth and high gain requirements. Persistent feedback can limit a child's ability to use amplification and may be an indicator that the acoustic coupling of the earmold to the child's ear is compromised. Therefore, feedback management should be activated for infants and young children as needed to minimize the likelihood of feedback. Activation of feedback management should occur prior to electroacoustic verification so that the impact of feedback management on audibility can be quantified. Manual reduction of high-frequency output of the hearing aid by the audiologist should never be utilized as a feedback management strategy.

10.2 FREQUENCY LOWERING

Frequency lowering increases audibility for high-frequency speech sounds that are above the frequency range of conventional hearing aid bandwidth. Frequency lowering should only be activated when high frequency audibility targets cannot be met with conventional processing. The range of frequencies between the intersection of the average and peak of long-term-average-speech spectrum (LTASS) and the child's audiogram with conventional processing is known as the maximum audible output frequency (MAOF) range. The MAOF range should be used to assess candidacy for frequency lowering and to determine the frequency lowering settings that will restore audibility for information above the MAOF without introducing unnecessary distortion. For a review of verification approaches for frequency lowering, see Scollie and colleagues (2016a).

10.3 NOISE MANAGEMENT AND DIRECTIONAL MICROPHONES

Background noise can lead to difficulties in communication and hearing in children who wear hearing aids. Noise reduction and directional microphones are used in hearing aids to minimize the negative perceptual consequences of background noise. Evidence to support the use of noise reduction and directional microphones for children in the age range of the BCEHP is currently limited.

Noise reduction decreases the output of the hearing aid when the input is determined to have the characteristics of background noise. Noise reduction is unlikely to improve speech perception (Stelmachowicz et al. 2010) but may improve listener comfort in background noise and increase the likelihood that a child could wear their hearing aids in noisy situations. Therefore, if appropriately verified to ensure that audibility for speech can be preserved, noise reduction should be considered for activation in infants and children. A discussion of noise reduction and verification protocols is available from Scollie and colleagues (2016b).

Directional microphones use multiple microphones or multiple ports on the same microphone to spatialize inputs to the hearing aid and reduce amplification for sounds originating from the sides or from behind the listener. Because directional microphones require the listener to orient towards the signal of interest, the benefits of directional microphones are unlikely to be realized by infants and young children (Ching et al. 2009). For these reasons, omnidirectional settings should be used for infants and young children. Activation of directional microphones should not occur until the child is old enough to orient towards talkers of interest. When directional microphones are activated, recent evidence suggests that a directional microphone system with automatic switching between omnidirectional and directional modes is likely to result in better auditory access than relying on the child to switch their directional microphones (Ricketts, Picou, & Galster, 2017).

11 EARMOLDS

11.1 EARMOLD STYLES

A shell style earmold with no vent is recommended for infants in order to maximize retention and avoid the negative acoustic effects of venting that can occur when the vent intersects the sound bore of the earmold. However, the choice of style is at the audiologist's discretion based on the individual needs of the child and the anatomy of their external ear. A helix-lock may help if retention is a problem, but parents should be carefully instructed on inserting earmolds correctly to prevent irritation or feedback from a helix-lock that is not placed properly.

For older children, venting may be desired depending on the degree and configuration of the child's hearing loss and to avoid unnecessary occlusion of the ear canal. Venting may impact the ability to conduct verification using SREM. RECD measures should be completed with a foam insert tip or with the vent occluded if there is a vent in the earmold. The Audioscan Verifit 2 incorporates venting compensation simulations that should be applied when SREM are completed with earmolds that have vents (Scollie et al. 2022). Open fittings or large vents are not recommended for children within the age range of the BCEHP as these couplings require in situ verification that is often not possible for infants and young children.

11.2 EARMOLD MATERIAL

Although earmold labs have a variety of brand names for their products, two main choices of pliable earmold material should be considered for infants: polyvinyl chloride (PVC) or silicone.

PVC (i.e., Skinflex) material is the most common material chosen for infants and young children. PVC accepts tubing glue and is stiffer in shape than silicone; therefore, PVC is preferable for children less than six months of age or for children with unusually small ear canals. Silicone materials do not accept glue and require the use of a tube lock or tubing retention ring to hold tubing in place. This can distort the shape of the earmold in small ear canals, causing irritation, reduced high-frequency output, and feedback.

Audiologists should inquire with parents or caregivers to determine if the child has known allergies to any earmold materials. In the rare event of an allergic reaction (e.g., itching, swelling, blistering, sore spots, lesions, or very rarely breathing difficulties or wheezing), an allergic coating is available (known as photocoating).

11.3 EARMOLD TUBING

For some infants, the size of the ear canal may limit the diameter of the sound bore and how deeply the earmold can be tubed. Tubing should extend to the end of the canal portion, if possible. Tubing size and type is at the discretion of the audiologist. Constrictions of the tubing at the termination of the sound bore should be avoided as these constrictions can create a reverse-horn effect and limit the effective high-frequency bandwidth of the hearing aid.

12 OUTCOMES VALIDATION

The goal of amplification is to ensure that a child's own speech and that of others is audible, comfortable and clear. Outcomes validation is the process of monitoring a child's functional abilities with their hearing aids over time. The most frequently used tools for validation are aided speech recognition assessment and parent or caregiver questionnaires. Information from outcomes assessments should be shared with parents/caregivers and the child's early intervention team.

Children who do not show progress over time on outcomes assessments should be considered for further evaluation to determine the factors that may be contributing to limited progress. At this time, there are no outcome measurement tools for infants and children less than five years of age that have sufficient validation to be used as the basis for changing amplification settings from prescriptive targets.

12.1 AIDED SPEECH RECOGNITION

Measures of aided hearing should be conducted with speech or speech-like materials whenever possible (see Section 9 for a discussion of verification of bone conduction hearing aids). Functional gain using pure-tone or narrowband noise stimuli is not recommended for validation of air-conduction hearing aids due to limitations related to how hearing aids process pure-tone sounds at low input levels and do not reflect speech audibility (ASHA 2000). For children who cannot complete aided speech recognition assessment or who have limited auditory skills with their hearing aids, detection can be completed using the calibrated recordings of the Ling speech sounds (Scollie et al. 2012).

Assessment of aided speech recognition is often possible around two years of age using a closed-set task, such as the Open and Closed Set Task (McCreery et al. 2015). Aided speech recognition should be assessed in soundfield at average speech levels (65 dB SPL) consistent with hearing aid verification to facilitate comparisons of aided audibility and speech recognition. Once a child reaches a ceiling level of performance on a closed-set task, open set monosyllabic words can be used, followed by sentences. Once children reach ceiling levels of performance in quiet, sentence recognition in background noise at a realistic signal-to-noise ratio (such as +6 dB) can be completed. See Uhler et al. 2017 for a comprehensive review of pediatric speech recognition test protocols.

12.2 AUDITORY QUESTIONNAIRES

Auditory questionnaires add an important element to the hearing aid validation and habilitation process. Questionnaires assess how a child hears in everyday situations and how their listening abilities are changing over time. As a part of the initial fitting with amplification, and ensuing follow-up, functional assessment questionnaires are recommended. Questionnaires are often available in a wide range of languages to facilitate input from families from diverse linguistic backgrounds.

Auditory questionnaires completed by the parents or caregivers can help to foster family involvement in the habilitation process and can help to encourage open communication between audiologists and family members. Questionnaires can increase awareness of areas of difficulty a family may be encountering. Auditory questionnaires also help parents, caregivers, and professionals to better understand the effects of the child's hearing loss and later on, the benefits derived from the hearing aids. See McCreery et al. 2015 for an example of auditory development questionnaires and outcomes for infants and children who wear hearing aids.

The following assessment tools have been selected for use within the BC Early Hearing Program:

- IT-MAIS – Infant Toddler Meaningful Integration Scale – Questionnaire completed as an interview with a parent. Useful up to 2 years developmental age.
- LittlEARS Auditory Questionnaire – Questionnaire completed with parent. Useful up to 2 years developmental age.
- ELF – Early Listening Function Discovery Tool for parents and caregivers of infants and toddlers. Useful up to 3 years developmental age.
- PEACH – Parent Evaluation of Aural/Oral Performance of Children – Questionnaire completed with parent. Useful from 2–5 years developmental age. Children under 30 months of age may have reduced scores simply because of age (see McCreery et al. 2015).

Although completion of an auditory questionnaire is not mandatory at this time, it is advised that the functional assessment should be completed within two months of the initial fit and again at one year post-fit. Additional administration is at the discretion of the audiologist. LittlEars and PEACH scores should increase over time with subsequent administrations. Speech, communication and language skills assessments are obtained by the BCEHP early interventionist working with the family.

12.3 MINIMAL PROGRESS IN AUDITORY DEVELOPMENT

If there is little or no benefit from appropriately fitted hearing aids that are worn consistently, the audiologist should consider additional audiological and hearing aid assessments to ensure that reduced audibility is not a factor. Referrals to other professionals may also be warranted in cases of speech and language delays that may be caused by other factors not related to reduced audibility.

13 FOLLOW-UP GUIDELINES FOR AMPLIFICATION

It is important to understand whether the amplification provided is appropriate and effective in the daily life of the infant and family. Depending on the outcome of the follow-up process, adjustments may be required. Parent-reported hearing aid use and datalogging are useful tools to assess whether families are able to use amplification across a wide range of listening situations.

13.1 FOLLOW-UP SCHEDULE

Follow-up audiological appointments should be scheduled at least once during the adjustment trial period (within 60 days of initial fit, preferably within one month) then at three month intervals for the first year of amplification, then every six months until age five years.

This follow-up schedule may vary with factors such as the stability of hearing thresholds, child and family adjustment to amplification, and other medical factors. Consider booking a maintenance appointment prior to audiological review. An earmold impression may need to be taken at this time so that the new mold will be ready in time for the appointment with the audiologist. This may save time in ensuring molds fit and the hearing aids are working.

13.2 FOLLOW-UP PROCEDURES

Follow-up appointments include a combination of the following:

EARMOLDS

Earmolds must be checked at every visit to ensure that they are in good physical condition, provide an appropriate seal and retention in the ear, and that feedback is not present. Increasingly effective feedback management algorithms have limited the utility of feedback as an indicator that earmolds need to be replaced. Earmolds may also need to be replaced if verification indicates that sufficient amplification cannot be obtained due to poor earmold fit.

LISTENING CHECK

The audiologist should listen to the hearing aids coupled to the child's own earmold at each appointment. Parents should also be given an opportunity to practice listening checks at each appointment.

PROBE MICROPHONE MEASUREMENTS

Probe microphone measurements (in situ or SREM) must be measured where possible each time earmold is changed or at least every six months.

BEHAVIOURAL AUDIOMETRIC EVALUATION

Behavioral assessment should be attempted by nine months corrected age and subsequently at least every three months until a complete ear-specific audiogram is obtained at 500, 2000 and 4000 Hz. After the first year and assuming complete ear-specific audiometric threshold information has been obtained, hearing should be reassessed behaviorally every 6 months. If reliable behavioral results cannot be obtained by 12 months of age, consultation with the BCEHP Program Support Audiologist regarding a possible referral for sedated ABR testing should occur.

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