PEDIATRIC
ADVISORY BOARD

Pediatric Focus 3

Hearing aid prescription and fine-tuning: The basics of preferred practices

The purpose of this guide is to summarize the key elements of best practice in pediatric hearing aid fitting and provide resources to help support clinical implementation.

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Introduction

Pediatric audiologists partner with families to support accurate hearing assessments and timely, beneficial hearing aid fittings for children who have hearing loss. We provide hearing aid fittings when families elect to pursue hearing access as one part of their plan for their child. In this context, our role includes providing speech audibility that is both comfortable and beneficial across a wide range of environments, delivered by a hearing aid that provides a stable physical fit for a young child, and that promotes regular daily use in support of auditory development. These are considered best practices (AAA, 2013) and are known important factors in the long-term speech and language development of children who are hearing aid users (McCreery et al., 2015; Walker et al., 2015a).

Consistency of implementation of best practices in pediatric amplification varies across countries, clinics, and clinicians, and can impact the quality of hearing aid fittings received by children who access our services (McCreery, Bentler, & Roush, 2013; Moodie et al., 2016b). Accurate hearing aid fitting is more challenging when the degree or slope of the hearing loss increases (Ching et al., 2015), and can be additionally complicated in children due to the increased likelihood of changing hearing loss. Children may have changes in hearing loss over time due to hearing loss progression and/or changing middle ear status with conductive overlay (McCreery et al., 2015; Pittman & Stelmachowicz, 2003). Protocols have been developed that provide specific steps to follow, equipment to use, and techniques for follow-up and monitoring, all with the young child in mind. This Pediatric Focus summarizes the key elements of preferred practices in pediatric hearing aid fitting and provides pointers to further resources that support implementation.

Age Ranges and Hearing Aid Fitting

Integration of pediatric hearing aid fitting into Early Hearing Detection and Intervention (EHDI; JCIH, 2019) programs means that we see children across a broad range of developmental ages and stages. When working with infants, the hearing aid fitting will be based, in many cases, on an audiogram that is predicted from ABR or ASSR measurements. The infant will likely be in a period of rapid ear growth that will continuously change the physical fit and ear canal acoustics, so that more frequent follow-up appointments and a range of solutions for coupling to the ear will be required (Roush & Jones, 2018). Toddlers, preschoolers, and school aged children will often use their hearing aids regularly and in a wide range of environments, and are more likely to incorporate remote microphone systems such as Roger in home, preschool, school, and recreational environments. Teens might move into a higher level of independence, and require support for extracurricular activities, entry into the workplace, volunteer and sport participation, and transition to adulthood. At all of these stages, best practices help us ensure that we are providing consistent hearing care that supports the child's changing listening needs.

First things first: The Transition from Hearing Assessment to Hearing Aid Fitting

We know that hearing aid gain, output, compression, and shaping provide greater benefit when they are well-matched to the hearing range of the hearing aid user: audibility is a necessary and important starting place. However, calculation of necessary output by frequency relies upon accurate hearing assessment, starting with the audiogram and implemented in the context of a comprehensive age-appropriate test battery (AAA, 2020). How was the child's hearing tested? For infants, we often base the first hearing aid fitting(s) on an electrophysiological assessment of hearing, with the end goal of predicting the infant's audiogram. The use of procedures to obtain frequency-specific hearing thresholds for each ear by air and bone conduction assessment are necessary to ensure that there is sufficient information to determine hearing aid candidacy and prescriptive targets.

An important start to infant hearing aid fitting is to ensure that accurate procedures are used for correcting and entering electrophysiological results. Do corrections need to be applied to the nHL values obtained? If so, which corrections should be used?

The corrections might need to be applied manually or through software-based functions depending on the equipment and protocols used. Omitting these corrections could mean that the hearing aid fitting may result in an inaccurate estimate of the audiogram, which is likely to result in over-fitting of the infant's hearing aids. An important start to infant hearing aid fitting is to ensure that accurate procedures are used for correcting and entering electrophysiological results. Summaries of the necessary considerations are available, and several suggest specific corrections that can be used in clinical practice (Bagatto, 2016; British Society of Audiology, 2019; Wiesner et al., 2018; 2019).

As infants develop, we can begin to use conditioned behavioural procedures for hearing assessment, including both Visual Reinforcement Audiometry (VRA) and Conditioned Play Audiometry (CPA). Best practices for these procedures are available (American Academy of Audiology, 2020; British Society of Audiology, 2014; Ontario Infant Hearing Program, 2019a). Just as with ABR/ASSR assessment, in most circumstances, hearing aid fitting based on VRA and CPA should not proceed unless the hearing assessment itself is deemed valid and interpretable, and contains frequency- and ear-specific information for both air and bone conduction (AAA, 2020). Evaluation of a minimum of two or preferably three frequencies per ear, for both low- and high-frequency stimuli are common recommendations.

Selecting a prescriptive target: Make speech audible and comfortable

Best practice guidelines recommend that the amount of amplification, shaping, and output limiting that is programmed into a child's hearing aid should be determined based on evidence-based practices, and should aim to make speech audible and comfortable across a wide range of frequencies, levels, and environments. For listening to speech in quiet, our most commonly-used strategy is to provide automatic volume control functions that have been set to the levels and shapes computed by a pediatric prescriptive algorithm. Multichannel wide-dynamic range compression or similar technologies can accommodate for different vocal effort levels and the level changes associated with short to medium distances (Davidson & Skinner, 2006; Marriage et al., 2005; Pittman et al., 2014). Pediatric prescriptive targets from either the DSL version 5 algorithm (Scollie et al., 2005), or the NAL-NL2 algorithm (Keidser, Dillon, Flax, Ching, & Brewer, 2011) have distinct settings for children. These provide predictions of pediatric ear canal acoustics and higher levels of gain to align with children's real-world preferences (Scollie et al., 2005; 2010). Recent studies indicate that ensuring a consistent, prescribed level of speech audibility through accurate use of the DSL prescription promotes auditory development (McCreery et al., 2015) and provides better outcomes for children with moderately-severe to profound hearing loss (Quar et al., 2013). Both the NAL and DSL targets have been shown to produce good long-term speech recognition and self-reported outcomes. Higher parental ratings of real world hearing performance have been reported for the DSL prescription for listening in quiet situations but not in noise (Ching et al., 2018).

Of these two options, the DSLv5 method includes additional infant-friendly features including corrections for ABR hearing assessment, and interpolation of targets for use when the fitting is based on partial audiograms. Targets are also available for use in noisy environments to manage loudness (Crukley & Scollie, 2012), and have been adapted for use with percutaneous bone-conduction hearing aids (Hodgetts & Scollie, 2017). DSL targets extend to 8000 Hz, with the goal of supporting broadband listening that is known to support speech sound recognition and rapid word learning (Gustafson & Pittman, 2011; McCreery et al., 2017; Stelmachowicz, Pittman, Hoover, Lewis, & Moeller, 2004; van Eeckhoutte, Scolle, O'Hagan, & Glista, 2020).

Figure 1 shows examples of software selections used when entering hearing assessment data from ABR, for a child aged three months.

Figure 1. Audiogram and type of hearing test, for a three-month-old infant.

Choosing hearing aids: features to consider

An important first step in selection is to find and choose a hearing aid model that has an appropriate fitting range for the child's hearing loss, allowing for the possibility of ear growth, hearing loss progression and/or conductive overlay, any of which may require more gain in the future than on the day of selection. We prioritize selection of a device with a low noise floor for children who have normal hearing at some frequencies, or those who have mild hearing losses (Bagatto, 2020; OIHP, 2019). It is important to know that manufacturer-suggested fitting ranges might not have been developed for pediatric fittings – relying only on these software-based suggestions rather than on verification and fine-tuning could lead to the selection of hearing aids that do not provide a good fit to targets (Folkeard et al., 2020). The vast majority of young children will receive behind-the-ear (BTE) style hearing aids fitted with soft earmolds due to their robustness and ease of accommodation of ear growth. Older children, such as teenagers, are more likely to be fitted with receiver-in-the-canal (RIC) style devices for cosmetic reasons (Roush & Jones, 2018). If choosing a RIC device, one should take care to choose a receiver power level that both fits in the ear and provides appropriate output levels; more powerful receivers tend to be larger.

Essential pediatric features such as compatibility with remote microphone systems (e.g., Roger), telephone accessibility and support, automatic access to noise management signal processing, and a range of options for physically coupling to the ear (Roush & Jones, 2018) are available in hearing aids at all technology levels. The vast majority of children will require these features at some point, so the experienced pediatric audiologist typically makes sure they are included at the time of selecting new aids even if they are not used in the earliest fittings. The pro-active selection of a fitting range and signal processing profile that is appropriate to the child's current and future needs helps to provide ongoing fitting over time without the need to exchange or re-purchase devices unnecessarily. Ensuring that families have good information about the technology and features for their child's unique needs and age range will empower them to make appropriate choices, including taking into account financial resources and priorities. Parents should have access to informed choice about appropriate technology and cost levels.

Setting up the hearing aid fitting: provide the necessary information

Although obvious, it is important to enter appropriate data into the fitting system when fitting the hearing aids, especially the first time. Clearly the audiogram needs to be entered, but other factors such as the child's age, earmold type, measured ear canal acoustics (usually the RECD, shown in Figure 2), and a selection of a specific prescriptive formula all provide details that are used by hearing aid fitting software to generate the default fitting. These data will affect the gain and frequency shaping that are programmed into the hearing aid. Some of these variables also affect the pre-selection of signal processing features using age-appropriate ranges (Phonak AG, 2013) or the activation of pediatric versions of signal processing algorithms (Feilner et al., 2016). Overall, the pre-fitting is more likely to be close to your desired result as you enter additional information into the fitting system.

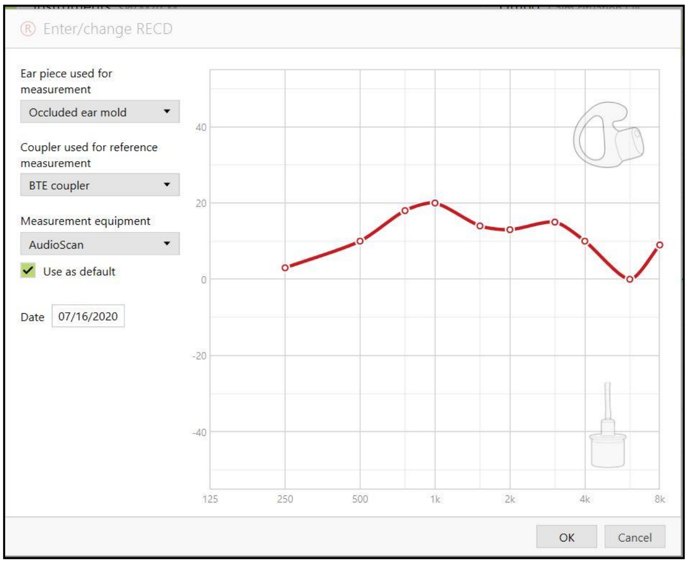


Figure 2. Data entry screen used to enter the real ear to coupler difference and earmold type, for a three-month-old infant.

Verifying the hearing aid using a hearing aid analyzer and fine tuning

Verification is the step most-often skipped in hearing aid fitting, yet it has evidence to support its routine use (Folkeard et al., 2020; McCreery et al., 2013; 2017; 2020). If your clinic does not own a hearing aid analyzer, it is imperative to invest in new equipment and training to successfully incorporate verification procedures in daily practice. Generic features to consider include third-octave band analysis of calibrated speech signals, good tests for noise reduction and directionality, stimuli for setting frequency lowering, headphones for listening checks, and support for testing remote microphone systems. A checklist can be helpful to track the provision of verification, specific features, and accessories (See Figure 7 below; OIHP, 2019b). Updates to software and/or accessories typically provide access to normative ranges, new test stimuli, or the ability to verify for bone-anchored hearing devices on a skull simulator.

After selecting and pre-fitting a child's hearing aids, it is time to determine whether the aided output is set appropriately. First, a verification location is chosen: ear or coupler? Probe tube microphones can be placed in the child's ear with the aided output measured directly, or the hearing aids can be connected to the coupler(s) and ear canal output can be predicted using RECD-based corrections (Moodie et al., 2016a). The RECD can either be measured directly (measured is preferred) or predicted based on the child's age (Bagatto et al., 2005). The younger the child, the more often the hearing aid is verified in the coupler. Young children and infants are less likely to sit without movement and vocalization in front of a loudspeaker for repeated real ear measurements while fine tuning is completed; RECD-based verification of gain and output was developed to overcome this problem (Seewald, Moodie, Sinclair, & Scollie, 1999). If an older child is able to perform real ear measures, then real-ear measurements could be done, particularly if a vented earmold or open dome is used; verification on a sealed coupler does not estimate the level of sound that enters through the vent. Real ear measures can be contaminated by room noise, patient noise, and reflections, so control of these factors is important. For small or unvented fittings, coupler and real-ear verification strategies will provide similar results, so there is no need to confirm a coupler-based verification with a real-ear measure. One or the other is fine and will save valuable clinic time.

Once the aid(s) is placed on the ear(s) or coupler(s), it is time to measure the aided output and compare the shape and level to the prescribed targets. Set the hearing aid analyzer to use the correct age, thresholds, RECD, prescriptive targets[1], and hearing aid style (e.g., BTE, RIC). Choose a calibrated running speech signal at a conversational level (60 or 65 dB SPL) and measure the hearing aid's aided response for speech. Some clinicians check the fit to targets for soft and/or loud speech as well. Take note of whether the hearing aid is either under or over target, and at which frequencies. Using the fitting software's frequency-specific gain controls, adjust the hearing aid to provide either more or less gain at those frequencies, and measure again. A high-level pure tone sweep (85 or 90dB SPL) or purpose-designed test signals (EUHA, 2015) is used to verify that the hearing aid is not exceeding targets for maximum output.

[1] Prescriptive targets are usually intended for use with a 1/3 octave analysis of speech so if the analyzer offers many choices for smoothing or FFT, the one that is recommended for use in target matching should be selected or the hearing aid will be set incorrectly.

Some fitters will assess the maximum output early on in fine tuning to make sure that it is set to targets because an unusually low maximum output response can limit the hearing aid's ability to meet speech-level targets.

A basic hearing aid fitting is complete when the aided speech response matches targets to within 5 dB and when the maximum output response does not exceed target by any more than 3 dB. Some clinical equipment will provide a summary measure of the overall fit to targets based on frequency response error from target (Latzel et al., 2017; Phonak, 2016) or the root-mean-squared error (RMSE) of the aided output level from the prescriptive target (McCreery et al., 2013; Moodie, Scollie, Bagatto, & Keene, 2017). Figure 3 shows an example of a basic fitting for mid-level speech and high-level maximum output, both tuned to appropriate levels (RMSE for speech is 0.9 dB). Getting the fitting to this point might take a few rounds of measurement and fine tuning but overall should only take a few well-spent minutes. Emerging technologies allow the fitting software and verification system to "link" or "integrate" with one another, which can make things a bit faster, and also can help ensure that menus are set the same way in both applications (Latzel et al., 2017; Folkeard et al., 2018). Manual fine tuning might still be needed even with these systems to maximize fit to target across all frequencies.

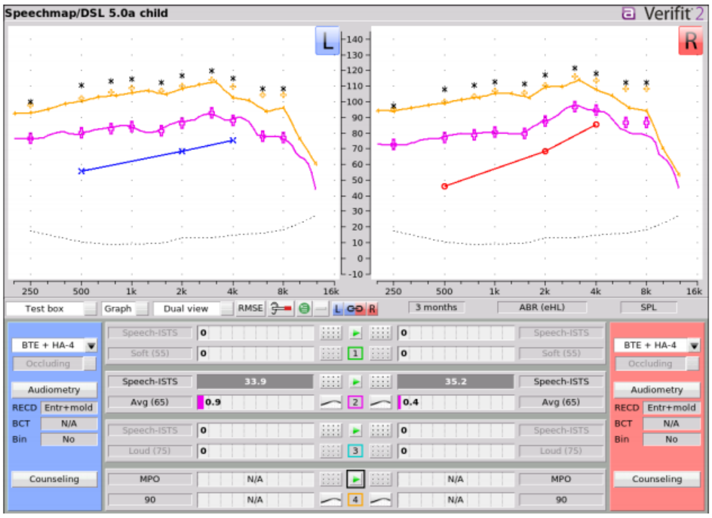


Figure 3. Basic hearing aid fitting, fine tuned to meet targets for mid-level speech and for output limiting.

Clinicians should also match the aided output to prescriptive targets for soft and/or loud speech, as shown in Figure 4.

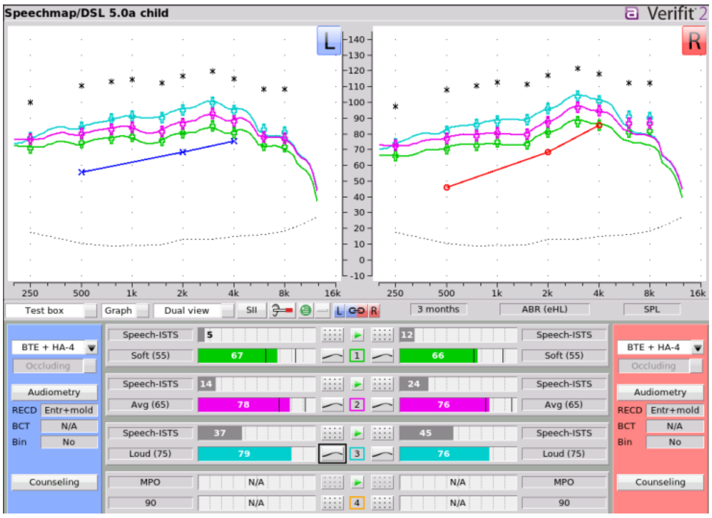


Figure 4. The same hearing aid fitting shown in Figure 3, verified for three levels of speech representing soft, average, and loud levels.

Once the fitting is completed, there are a number of other tests that can be run or scored to provide additional information, or help with troubleshooting. Many hearing aid analyzers now support listening to the hearing aids over headphones to check sound quality and streaming. Listening checks are a valuable routine practice, because they may help with troubleshooting and counselling. If the hearing health care professional uses assistive listening technology, it is often possible to patch into the headphone jack to have access to listening checks.

Many clinicians also like to have a look at the automatically-provided aided Speech Intelligibility Index (SII) for the aided speech responses. This handy number tells you the percentage of speech that is available to the child in each ear. Although the SII is not a predictor of speech recognition scores, it is a good indicator of long-term outcomes in that the aided SII should be higher than the unaided SII (Scollie, 2018; McCreery et al., 2015) and should have an appropriately high aided value. Normative data and a scoring sheet are available (Bagatto et al., 2011; Moodie et al., 2017). For the fitting shown in Figure 3, the three-frequency pure tone average is 50 dB HL (left ear) and the Aided SII for mid-level speech is 82%. This places the SII within the typical range shown for the hearing loss, as marked with "X" in Figure 5. This typical range is also depicted in Figure 3 with two vertical black lines: note that the 82% value falls within the range. These two tools are two views of the same assessment.

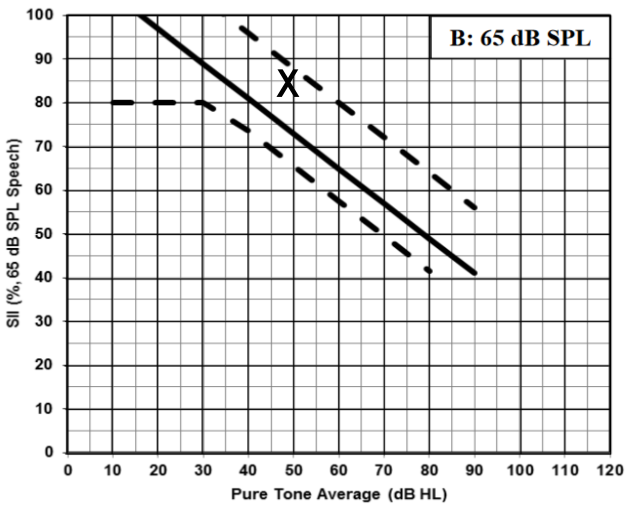


Figure 5. Evaluation of the aided SII value from Figure 3 against a typical range for this value.

Aided SII values are helpful in counselling parents and teachers about the impact of hearing aid use on speech access (Scollie, 2018). Recent evidence suggests that children with mild hearing loss may be considered hearing aid candidates if their unaided SII is less than 80% (McCreery et al., 2020).

Placing the hearing aids on ears, coaching, and checking for acoustic feedback

The next step is to place the hearing aid(s) on the child, and coach caregivers on hearing aid use and maintenance. Particularly when hearing aids are new, there is a lot to cover. Checklists can aid this process by ensuring that important topics aren't missed. Videos, apps, or print materials can provide coaching information for use at home. During in-person coaching, it is recommended that a teach-back method be included so the parents are asked to repeat what they have learned, and to practice placing the hearing aid(s) on their child during the session in order to gain confidence. When a hearing aid is placed on the child for the very first time, parents are also seeing this physical representation of their child's condition for the first time. Giving space for the emotions a family may be experiencing is essential.

During this process, we also must ensure that the aid is stable on the ear, and can be worn without feedback. Especially if the aid was fitted on a coupler rather than with real-ear measures, it may feed back on the ear even if it had no feedback on the coupler. Therefore, it's important to remember to check this while there is still time left in the appointment to make any needed adjustments before the child and family head home. Especially when working with new families, this same time in the appointment might also be the time when parents are being shown how to insert the hearing aids, and this important activity needs time as well. If feedback occurs, during insertion, we can lengthen the duration of time the hearing aid is muted before turning on to give more time for the insertion process. If feedback occurs when worn, we can activate or re-adjust software-based feedback managers. Some feedback managers will maintain the hearing aid's fit to targets while others will reduce or limit high frequency gain; some clinical protocols advise re-measuring the aided output after activation of a feedback manager to check directly for any loss of speech audibility (AAA, 2013). Feedback can also be managed through low-tech solutions like earmold lubricant (Roush & Jones, 2018). Feedback happens at some point in almost any fitting and can be frustrating. It's important to provide resources for new parents about expecting feedback with growth and hugs and car seat head restraints, and let them know to come back and see you when feedback worsens as ears grow (Phonak, n.d.a.).

Advanced features and hearing aid follow-up

Infants, toddlers, school-aged children, and teens are in noisy situations a lot of the time – this includes both daycares and schools, retail stores and malls, the car, and playgrounds (Crukley, Scollie, & Parsa, 2011; Scollie et al., 2010). Signal processing is typically available in hearing aids, and activated by default, to accommodate quiet versus noisy situations. Noise management for children is encouraged in some hearing aid protocols, with associated verification procedures to evaluate the overall strength of noise reduction signal processing and to emphasize automatic activation of the feature rather than having the child or parent manually access it (Ontario Infant Hearing Program, 2019b; Scollie et al., 2016b). Pediatric considerations for directional processing are summarized elsewhere (Lewis & Bagatto, 2017). Telephone access to landline and/or mobile phone signals is important to check as the infant becomes a toddler and moves through preschool and school years. Across ages, children make active use of telephones for communication with family members, for safety, and for social and work purposes. Accessibility to a functional phone strategy is an essential item on the to-do list, and enters the life of a child at a very young age. A plethora of technological solutions exists!

Some children require additional features in their hearing aids to meet their listening needs. One example is frequency lowering signal processing, such as SoundRecover 1 and 2. These signal processors can be activated and fine-tuned for an individual child. Typically, we enable this type of processing if the basic hearing aid fitting is not able to provide access to high-frequency sounds. Specific test stimuli that simulate "s" and "sh" are available in several hearing aid analyzers, and evidence-based steps allow for setting the strength of frequency lowering for each child (Glista et al., 2016; Scollie et al., 2016a). Benefit from frequency lowering is mainly for high frequency speech sound detection and recognition, and some children might require a period of acclimatization (Glista et al., 2012; 2016; 2017).

The hearing aid fitting from Figure 3 was assessed for audibility of "s" with SoundRecover2 disabled, to check if the hearing aid fitting provides full audibility without frequency lowering. For this moderate hearing loss, good audibility for "s" is provided (Figure 6), without the need for frequency lowering, assuming that the slope of the hearing loss through 8000 Hz will be similar to the partial audiometric thresholds that are currently available. More audiometric data could change this decision in future. More severe and/or sloping losses are expected to require some amount of frequency lowering in order to achieve similar audibility of "s".

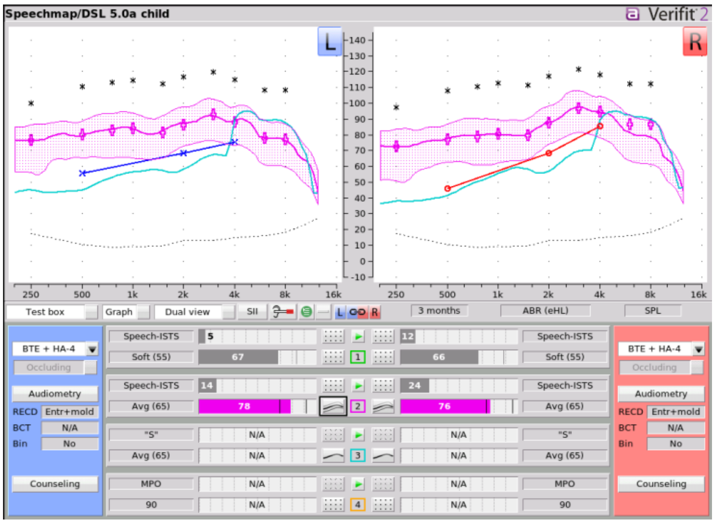


Figure 6. Verification of aided levels of "s" (blue) versus the basic hearing aid fitting for mid-level speech (pink).

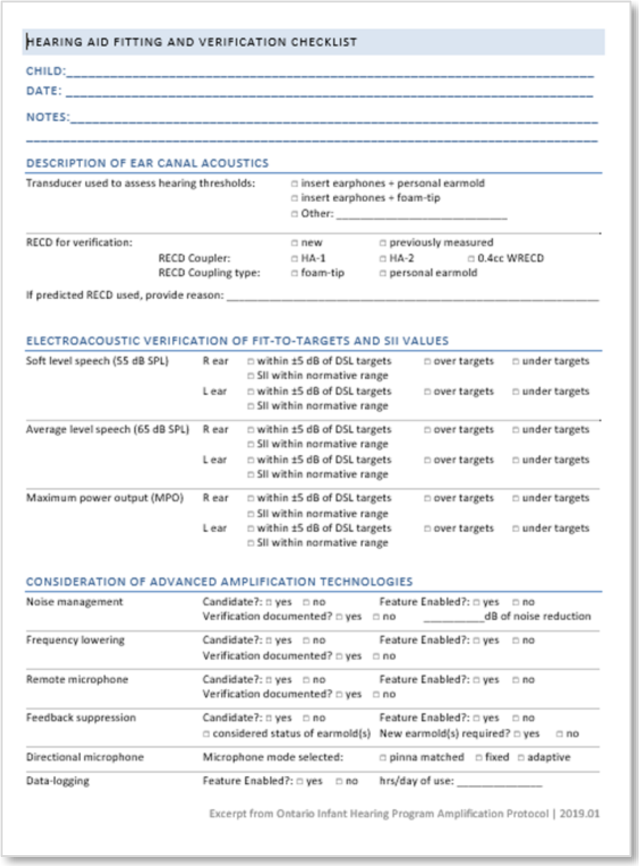
Remote Microphones

Some children use remote microphone systems at home (Benítez-Barrera, Angley, Tharpe, 2017; Benítez-Barrera, Thompson, Angley, Tharpe, 2019; Curran et al., 2019; Walker et al., 2019), at daycare, at sports, or at school. These systems are now more seamlessly integrated into the hearing aid input, with automatically-activated programs that receive the remote mic signal and mix it with the hearing aid microphones. Detailed protocols are available for the verification of these systems to ensure and document that signal transmission is successful (AAA, 2011; Ontario Infant Hearing Program, 2019b), and to monitor the outcomes of the system in the school environment (AAA, 2011). Listening checks are an important component of understanding the functions of a specific remote-mic-and-hearing-aid combination, and are also helpful for teaching and troubleshooting. Often listening tubes are used for this purpose, but have several problems. For example, if the hearing aid is too loud for a normally-hearing parent, audiologist, or teacher, this practice can be uncomfortable or even intolerable unless a strong damper is fitted to the listening tube. Conversely, if the parent, audiologist, or teacher uses hearing aids or cochlear implants, listening with a listening tube might not be possible. Headphones provided with hearing aid analyzers could be a solution to these issues for listening checks in the clinical setting: a normally hearing listener can adjust the headphones level to a comfortable volume, and a hearing-impaired listener can either place the headphones over their own device microphones or connect their own remote mic in place of the headphones.

Follow-up and keeping track of the details

If the task of optimally selecting, fitting, and verifying hearing aids for children seems like a lot of effort, it is. In the end, though, the effort is worth it! The combination of hearing aid functions and development across the lifespan means that the pediatric audiologist has a lot to consider when keeping track of a child's needs across the lifespan and an almost infinite number of factors pertaining to hearing aid function and technology. One example of a short checklist is shown in Figure 7 (Ontario Infant Hearing Program, 2019b). Checklists can summarize progress on the to-do list across several appointments to help clinicians track and remember what has been set, verified, and adjusted and what we may still need to consider.

Other aspects of follow-up include revisiting the basics: re-testing hearing, re-measuring ear canal acoustics, and re-setting the hearing aid to new settings to keep up with any changes. It's also important to remember to make changes and provide support strategies as new technologies emerge and as the child's needs change. Recent advances in hearing technology include applications that can be installed on the parent's phone. These apps include interactive user guides with instructions and troubleshooting tips that are tailored to the specific make and model of a child's hearing aids. Unlike a paper user's guide that will be left in a drawer, parents will be able to have this guide with them, readily available on their phones. These free apps can be shared



HEARING AID FITTING AND VERIFICATION CHECKLIST

CHILD: ____________________

DATE: ____________________

NOTES: ____________________

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DESCRIPTION OF EAR CANAL ACOUSTICS

Transducer used to assess hearing thresholds:	□ insert earphones + personal earmold		
	□ insert earphones + foam-tip		
	□ Other: ____________		
RECD for verification:	□ new	□ previously measured	
RECD Coupler:	□ HA-1	□ HA-2	□ 0.4cc WRECD
RECD Coupling type:	□ foam-tip	□ personal earmold	

If predicted RECD used, provide reason: ____________________

ELECTROACOUSTIC VERIFICATION OF FIT-TO-TARGETS AND SII VALUES

Soft level speech (55 dB SPL)	R ear	□ within ±5 dB of DSL targets □ SII within normative range	□ over targets	□ under targets
	L ear	□ within ±5 dB of DSL targets □ SII within normative range	□ over targets	□ under targets
Average level speech (65 dB SPL)	R ear	□ within ±5 dB of DSL targets □ SII within normative range	□ over targets	□ under targets
	L ear	□ within ±5 dB of DSL targets □ SII within normative range	□ over targets	□ under targets
Maximum power output (MPO)	R ear	□ within ±5 dB of DSL targets □ SII within normative range	□ over targets	□ under targets
	L ear	□ within ±5 dB of DSL targets □ SII within normative range	□ over targets	□ under targets

CONSIDERATION OF ADVANCED AMPLIFICATION TECHNOLOGIES

Noise management	Candidate?: □ yes □ no Verification documented? □ yes □ no	Feature Enabled?: □ yes □ no _______dB of noise reduction
Frequency lowering	Candidate?: □ yes □ no Verification documented? □ yes □ no	Feature Enabled?: □ yes □ no
Remote microphone	Candidate?: □ yes □ no Verification documented? □ yes □ no	Feature Enabled?: □ yes □ no
Feedback suppression	Candidate?: □ yes □ no □ considered status of earmold(s)	Feature Enabled?: □ yes □ no New earmold(s) required? □ yes □ no
Directional microphone	Microphone mode selected:	□ pinna matched □ fixed □ adaptive
Data-logging	Feature Enabled?: □ yes □ no	hrs/day of use: ________

Excerpt from Ontario Infant Hearing Program Amplification Protocol | 2019.01

Figure 7. Hearing aid verification checklist used in Ontario's Infant Hearing Program.

with grandparents, caregivers, teachers, or others in the child's life to help support device use and troubleshooting. Enhanced remote controls within the app can help with situational hearing management and might provide links back to the child's audiologist for further support in future.

These tools, and data logging built into the hearing aid, are powerful ways to monitor and support daily use (Gustafson et al., 2017). Hours of use is another key predictor of long-term outcomes, and recent normative data is now available (Walker et al., 2015b). Establishing appropriate, encouraging, attainable, and beneficial habits for daily hearing aid use is important, and online parent resources are now available that give information (https://ochlstudy.org/parent-handout) or videos with tips (Moodie & Sindrey, n.d.). Increased use time per day as children get older is typical, so one recommended goal is full time use of 10 or more hours per day when children are older and less likely to nap regularly (Walker et al., 2015).

Appropriate daily use of optimized hearing aid(s) should result in positive developmental effects for the child with hearing loss (Moeller et al., 2015). Specific tools are available to measure progress in children who wear hearing aids. Outcome measurement is an important part of the hearing aid fitting process because it can highlight areas that require modifications within the hearing care pathway. Published protocols for monitoring are available and include caregiver questionnaires as well as clinic-based listening tasks that provide normative data and/or performance ranges (AAA, 2013). The tools vary in their goals and target age range. For example, the Pediatric Minimum Speech Test Battery (PMSTB; Uhler et al, 2017) describes a list of available tools that assess the hierarchy of listening skills for a variety of ages from infancy to school age. The University of Western Ontario Pediatric Audiological Monitoring Protocol (UWO PedAMP; Bagatto et al, 2011) includes caregiver questionnaires (e.g., LittlEARS, PEACH) to assess auditory development and performance at young ages. The Ling6(HL) test (Glista et al, 2014) measures detection of speech sounds, which can be used to compare aided and unaided responses. Online resources provide interactive assessments that are used for functional assessments (Phonak, n.d.-b).

Regardless of the tools used, clinicians will benefit from knowing the child's daily hearing aid usage and aided SII so that the outcomes can be interpreted properly. We should also know how to properly choose and administer the tools so that the available norms can be used. Monitoring the child's progress using systematic and evidenced-based tools supports a valid outcome measurement process.

Measuring the impact of the hearing aid fitting includes the caregivers in a meaningful way. They know the child best and have valuable information to inform what we do. The relationship between the family and the audiologist has the potential to be long-term and consequently requires a mutually respectful relationship. As noted in a conceptual model of healthcare service coproduction (Hands & Voices, 2019), healthcare services should be co-produced by patients and professionals and not be viewed as a 'product delivered'. Good outcomes are more likely if the parents and audiologist communicate effectively, develop a shared understanding of the problem and generate a mutually acceptable evaluation and management plan.
As we work with the child and family, we may notice a lack of progress in auditory development. This could be due to many reasons such as a change in hearing, device malfunction, reduced daily hearing aid usage, decrease in language exposure, or change in overall health. Collaboratively with the family and other team members, we must determine the root cause of the limited progress. Open and consistent communication is key to continued support for the child and family. Referrals to other centers of specialization (i.e., cochlear implant) and ensuring families are aware of all of their options are necessary components of our work.

Final thoughts

Pediatric-focused clinicians have a commitment to not only our ongoing education but also to having the necessary equipment in our clinics. Appropriate skills and procedures are also necessary for accuracy in pediatric hearing aid fitting.

Hearing aid technology works best when it is well-matched to the needs of the individual child. Audible speech across a wide range of levels and sounds can be provided with hearing aids that are worn consistently: this has been shown to support good language development, especially when the child is in a rich language environment (Tomblin et al, 2015). Parents as partners are the facilitators of daily use and language access, and need our best support through timely, accurate, and high-quality services.

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