Establishing a Sound Foundation Through Electroacoustic Verification

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Provision of Hearing Aids

• Suitable technology and evidence-based hearing aid fitting guidelines and protocols support accurate and safe hearing aid fittings for the pediatric population
  • American Academy of Audiology, 2013
  • Australian Protocol; King, 2010
  • British Columbia Early Hearing Program, 2006
  • Modernizing Children’s Hearing Aid Services, 2005
  • Ontario Protocol; Bagatto, Scollie, Hyde & Seewald, 2010;
  Updated in 2014: www.dslio.com
AAA Pediatric Amplification Guideline (2013)

Assessment, candidacy, support

Device selection, earmold selection, prescription

Verification and fine tuning (probe mic) with speech & for each feature

Validation (outcome measurement) for every child

To ensure that needs are met

After new features
Ontario Infant Hearing Program Protocol

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www.dslio.com
Ontario Infant Hearing Program Protocol

• Document addresses provision of Amplification to infants and pre-school children registered in the Ontario Infant Hearing Program (IHP)

• Specific context and procedures including specification of key procedures and equipment requirements

• Updates to evidence are intended to support current clinical practice within IHP (& other jurisdictions)

• Aligns with AAA Pediatric Amplification Guidelines (2013)
Factors Influencing Outcome

Outcomes of Children with Hearing Loss

Ear & Hearing, 2015

Moeller, Tomblin, McCreery, Walker, Arenas, Harrison, Spratford, Bentler, Holte, Roush, Oleson, Van Buren, Ambrose, Unflat-Berry
Babies are not Small Adults

Early hearing loss impacts communication development

- Maximize critical period

Small ears that are growing

- Account for changes in ear canal acoustics

Depend on caregivers for hearing aid use

- Cannot provide verbal feedback
Assessment for Amplification

- Hearing assessment
- ABR corrections (if needed)
- RECD
- Prescriptive calculations
Best Practice: ABR Corrections

Ensure a smooth transition from electrophysiologic hearing assessment to early hearing aid fitting: *standardized nHL to eHL corrections, if needed.*

Bagatto et al 2005; Gorga et al 1993; McCreery et al 2015; Stapells et al 2005; Stapells 2000
Assessment for Hearing Aid Fitting

- Connect inserts to personal earmolds for follow-up audiograms
  - Better retention and acceptance
  - Sets you up for a more accurate hearing aid fitting
    - Earmold Audiogram
    - Earmold RECD

AAA 2013; Moodie et al 2016
Best Practice: Measure the RECD

Account for the child’s unique ear canal: measure the Real Ear to Coupler Difference (RECD) with the child’s earmold, routinely.

Bagatto et al 2002; Feigin et al 1989; Lewis & Stelmachowicz 1993; Munro & Davis 2003; Sinclair et al 1996; Tharpe et al 2001
Audiometry & RECD with Earmolds

Trim Earmold Tubing

Trim Tube from Foam Tip

Connect Earmold to Insert Earphone

Spacer

Spacer
What does using the *earmold* for audiometry & RECDs have to do with verification?
RECD is used in **two** places:

**HL Threshold + RECD + RETSPL**

= Real-ear SPL Threshold

**Coupler SPL or gain + RECD + MLE**

= Predicted Real-ear SPL or gain

For BTEs this needs to account for the earmold!

Gagne et al 1991; Munro et al 2001; 2003; Revit 1997; Scollie et al 1998
RECDs Measured with Foam Tips vs Earmolds are Not the Same

- Foam tip tubing is 25mm long
- Earmold tubing is usually longer
- High frequency roll-off results

Let’s call this: “Coupling Type”

36 children
Avg tubing = 38mm
Moodie et al, 2016
Coupling Type: Foam tip vs Earmold

• What if you need one type and only have the other type?
  • Example: foam tip audiogram, earmold RECD
  • Age trends for both types are known (Bagatto et al 2002; 2005).

• DSL v5.0 will generate a predicted RECD for either type
  • These might be used instead of measured RECD if the Coupling Type is not matched between RECD type and RECD usage
ANSI 2013 Standard Uses HA1

• Conceptually, this accounts for the acoustic properties of the ear cavity and not designed to measure anything about earmolds
  • *Means that verification would use the HA1 coupler + putty (another solution now available)*

• Conversion between HA1 and HA2 is applied
  • Simple, well-understood and easily transformed by software
In the Clinic.....

• Can use **HA2** coupler for coupler portion of RECD

• **Clinical** advantages: *No putty*
  • Fewer infection control issues
  • Faster, more reliable connection

• **Standardization** advantages:
  • HA1 RECD can be constructed & reported by software even though it wasn’t measured that way

• Let’s call this: “**Coupler Type**”
New software functions for the RECD are appearing

Goal: to comply with the ANSI standard, but also to support a wide range of clinical practice.

Note: Specific to Audioscan® systems

Text course: http://www.audiologyonline.com/U/26580/298f27b4d409b3a65e
Pediatric Fitting Protocol
(historical, and relies on “matching” for accuracy)

Matching
✓ Audiometry with insert phones + earmolds
✓ Measure RECD with earmolds
✓ Verify BTE in HA2 coupler

Mis-Matching
✓ Audiometry with insert phones + foam tip
✓ Measure RECD with earmolds
✓ Verify BTE in HA2 coupler

Coupler Verification
Good for infants & young children
Likely little or no venting

Gustafson et al 2013
New software systems allow you to label the **RECD type**. This supports **new corrections** that handle mismatches.

- Label the **type of coupler-based fitting**:  
  - HA2 or HA1? **COUPLER TYPE**
- Label the **type of RECD** you are measuring:  
  - With earmold or tip? **COUPLING TYPE**
- If necessary, the software will convert between foam tip & earmold RECDs using a **new correction procedure**.
- Preliminary data suggest this may be more accurate than using age-predicted averages (Moodie et al, 2016; JAAA).
Best Practice: Real-ear Verification

Set the hearing aid for the infant in the coupler, focusing on the long term levels of conversational speech: *verify every hearing aid, and fine tune to target. Use speech-based equipment.*

Munro et al 2000; 2002; Moodie et al 1994; Revit 1997; Scollie et al 2005; Seewald et al 1999
Why verify?

To provide the best possible fittings.

“The responsible audiologist wants to know as much as possible about the levels of amplified sound that hearing instruments deliver into the ears of infants and young children. To this end, the audiologist must apply comprehensive and evidence-based verification strategies that are compatible with the characteristics and capabilities of this unique population. This is because the long-term implications of the fitting decisions we make are simply too important.”

~ Richard Seewald
Goals for Verification

✓ Accuracy & reliability
  • Electroacoustic verification in the coupler

✓ Speech-like levels & MPO

✓ Infant-friendly procedures
  • There should be no requirement to sit up or respond behaviorally

✓ Meaningful displays
  • dB for dB comparison to thresholds & upper limits
Characteristics of the Aided Audiogram

- Does it tell us how the hearing aid processes speech?
  - No

- Suitable for Validation
  - No

- Verification
  - No

- It is meaningful?
  - Yes
Electroacoustic Verification - SPLogram

Predicted from coupler measurements & the RECD

Decibels Sound Pressure Level vs. Frequency (Hz)
Clinical Implications

• Coupler measures & RECDs allow accurate and reliable prediction of real-ear hearing aid performance
  • Across ages
  • Across frequencies

• Reduces time/cooperation needed
  • Your patient must sit for ONE measurement
  • You already measured the for Assessment
Specifics of Verification

• “Auto” or “First” fit is a starting place
  • Fine-tuning using real-ear equipment is necessary
  • View on SPLogram with measured RECD

• Speech-like signals are recommended
  • Soft (55 dB), average (65 dB), loud (75 dB)
  • MPO (narrowband; 90 or 100 dB)

• Target of choice is REAR not REIG
Other Analyses

• The Speech Intelligibility Index (SII)
  • An updated version of the Articulation Index (AI), standardized in 1997

• How to interpret:
  • 0 means no speech is audible
  • 1 means 100% is audible
  • This doesn’t mean that 100% will be heard correctly.
Speech Intelligibility Index (SII)
Pediatric Norms

Bagatto et al 2011; 2016; McCreery et al 2013; Stiles et al 2012
Verification Protocol

✓ Obtain ear-specific hearing levels
  • Correct ABR if necessary
  • Use earmolds for follow-up behavioural assessments
  • Measure the RECD with earmold

✓ Calculate targets & select device
  • BTE with small filtered earhook & DAI
  • Lock controls & battery door

✓ Verify for speech & maximum output
  • Deactivate advanced technologies
  • Coupler-based verification

✓ Follow up every 2-4 months
  • Outcome measures & reports from caregivers
  • Re-assess thresholds & RECDs (earmolds!) and re-adjust
ADDITIONAL HEARING AID TECHNOLOGIES FOR CHILDREN
Ontario Protocols

• Noise Management
  • Scollie et al, 2016, JAAA

• Frequency Lowering
  • Scollie et al, 2016, JAAA

• Candidacy themes:
  • Case-by-case
  • Factors to consider
Noise Management in Pediatric Hearing Aid Fitting

Ching et al 2010; Crukley et al 2011;2014; Humes et al 2003; McCreery et al 2012; Pittman et al 2011; Stelmachowicz et al 2010;
Get acquainted with your NR system

Does it affect speech in quiet?

Does it reduce noise?
Strength of Noise Reduction Varies

OFF

MINIMUM

MEDIUM

MAXIMUM
Take Home Messages

• A measured RECD is necessary for an accurate description of your patient’s ear canal which individualizes the hearing aid fitting

• RECDs are used to convert HL to SPL and allow for coupler-based verification

• Simulated REAR is a valid way to assess hearing aid performance for infants & children

• Consider other hearing aid technologies (noise reduction, frequency lowering) on a case-by-case basis

• If activated, verify the characteristics, impact on audibility and benefit
Good Fittings Contribute to Good Outcomes

- Linguistic Input
- Consistent Hearing Aid Use
- Audibility