



Fitting of Remote Microphone Hearing Assistance Technology to Children in an Educational Setting: Best Practices

Background Summary

The College of Speech and Hearing Health Professionals of BC approved the adoption of these guidelines developed by The Board of Hearing Aid Dealers and Consultants (BHADC) in collaboration with partners in the Ministry of Healthy Living and Sport, the Ministry of Health Services, the Ministry of Education, the Provincial Resource Program -- Auditory Outreach (PRP-AO), the BC Early Hearing Program (BCEHP) and the Public Health Prevention Directors Council undertook a review related to the fitting of personal Remote Microphone Hearing Assistance Technology (RMHAT). A working group was formed to review best-practice. This working group consisted of audiologists from the BHADC, the Public Health Audiology Council, the BCEHP, the PRP-AO, the School of Audiology and Speech Sciences at the University of British Columbia, and the Hearing Disorders and Cochlear Implant Programs at BC Children's and Women's Hospital. Specifically, this review of evidence led to the development of best-practices for the fitting of RMHAT to the school-aged paediatric population, for use in the educational setting.

I. Best Practice Documents reviewed

- a) **AAA** - American Academy of Audiology Clinical Practice Guidelines: Remote Microphone Hearing Assistance Technologies for Children and Youth Birth-21 Years. 2008
- b) **AAA Supplement** - Supplement A. Fitting and Verification Procedures for Ear-level FM
- c) **ASHA** – American Speech-Language Hearing Association Guidelines for Fitting and Monitoring FM Systems 2002
- d) **CASLPO** – College of Audiologists and Speech Language Pathologists of Ontario – Preferred Practice Guidelines, Appendix F: Fitting of FM Systems and Assistive Listening Devices for Children
- e) **Phonak and Cochlear Corporation Product Information** – Specifically for the Osseointegrated Auditory Implant (BAHA) and FM.

II. Key Service Providers

The key service providers are those who would primarily be involved in the selection, fitting and on-going support for RMHAT fitted to school-aged children with hearing loss. Children with multiple needs may require the involvement of additional care workers. The availability of key service providers may vary between Health Authority and School District.

- a) Audiologist
- b) Public Health Audiometric Technician and other Communication Health Assistants
- c. Auditory Outreach Program Team

- d. Teacher of the Deaf and Hard of Hearing/Hearing Resource Teacher
- e. Educational Assistant
- f. Classroom Teacher

III. Best Practices

a) Selection of RMHAT

The selection of appropriate RMHAT should include assessing the child's auditory skills and the current level of communication function, and identification of other factors that may influence device use in the educational setting. 1 2

An audiologist, with experience and/or training in working with paediatric populations and RMHAT systems, is the most uniquely qualified person to recommend equipment, in consultation with the school-based team. 3 4 5

b) Verification

Once an appropriate RMHAT has been selected, the performance of the system should be verified before fitting on a child/youth. 6 An audiologist, with experience and/or training in working with paediatric populations and RMHAT systems, is the most uniquely qualified person to verify a personally fit RMHAT system. 7 8

c) Validation/Monitoring

The validation process should begin immediately after fitting and verification, using both objective and subjective measures. With appropriate training, service providers could be qualified to do the following:

teachers of the deaf and hard of hearing/hearing resource teachers, classroom teachers, educational assistants and other school support personnel could conduct daily checks of the RMHAT system, teachers of the deaf and hard of hearing/hearing resource teachers could troubleshoot, and educational personnel could administer questionnaires/tools to assess functional outcome measures. 9 10

IV. Use Cases Requiring Verification plus Validation

An audiologist, with experience and/or training in working with paediatric populations and RMHAT systems, is the most uniquely qualified person to verify a personally fit RMHAT system.

a) RMHAT coupled to Hearing Aids

For wireless technology, a receiver is either integrated into the hearing aid (at time of manufacture), or coupled to the hearing aid either directly or through a shoe/boot. The combination of hearing aid + receiver is then viewed as a unit. In the following scenarios, electroacoustic verification should be performed.

- i. New RMHAT (FM)/ Hearing aid fitting – RMHAT receiver coupled to student's own hearing aid.11,12
- ii. Hearing aid with built-in RMHAT 13

b) RMHAT coupled to Cochlear Implants 14

- i. Behavioural verification, using appropriate speech recognition materials that are dependent on a child's communication abilities, is the most appropriate way to verify and validate a fitting.

c) RMHAT coupled to Osseointegrated Auditory Implant

i. Behavioural verification, using appropriate speech recognition materials that are dependent on a child's communication abilities, is the most appropriate way to verify and validate a fitting.¹⁵

d) RMHAT only (no hearing aid, cochlear implant or osseointegrated auditory implant) when fit because child requires optimal signal-to-noise ratio in classroom

i. Ear-Level RMHAT only with tube or earmold^{16,17} - real ear measurements is the most appropriate way to ensure that maximum output from the device does not reach a potentially damaging level.

V. Use Cases Requiring Validation Only

With appropriate training, service providers listed in III © above could validate equipment in the e following situations:

a. Personal RMHAT with headsets

b. Hearing aid repaired, including one with replaced amplifier or new serial number following recasing.

c. RMHAT (FM) Transmitter has been replaced with same or different model (requires confirmation of frequency)

d. Accessories, including boots/shoes, microphones and cords

VI. Practices, where there is no evidence-base

Some service providers have indicated concerns, and believe that verification should be conducted when RMHAT (FM) receiver has been replaced with same model

As research becomes available in this area, evidence will be reviewed and considered whether it meets the criteria of a best practice.

Technology Definitions

Amplitude -- The "size" or "magnitude" of a sound. Amplitude is usually expressed in decibels.

BAHA – Bone anchored hearing aid. (See Osseointegrated Auditory Implant).

Behavioral evaluation -- Measuring amplification benefit in terms of speech recognition by the intended user. (See Electroacoustic Evaluation).

Boot – See shoe

Electroacoustic Evaluation -- Measuring the performance of an amplification system in terms of sound amplitude and signal-to-noise ratio. (See Behavioral Evaluation, Amplitude, and Signal-to-Noise ratio).

Cochlear implant -- a device which provides sound to people with severe to profound sensorineural hearing loss. The device consists of two parts: a surgically placed internal implant and an external speech processor.

Cord connects a hearing aid via the shoe to a separate or body-worn receiver. (See Shoe, Receiver)

dB SPL (dB Sound Pressure Level) -- The decibel level of a sound in relation to a standard level defined for purpose of sound measurement.

FM Channel -- A narrow range of radio frequencies within the band allocated for FM amplification. Each channel is identified by number, letter, or color. The transmitter and the receiver must be set to the same channel.

FM Level Advantage -- The increase in decibel output level when the FM signal is added to, or substituted for, the signal from the aid's own microphone.

FM Receiver -- The device that detects the transmitted radio wave and recovers the sound signal for delivery to the hearing aid or other hearing device. Connection options include:

Integrated - receiver is built-into the personal device

Dedicated - the receiver is compatible with one case design

Universal - receiver works with multiple devices depending on the interface between the device and the receiver, i.e., a 3 pin polarized connection).

FM SNR Benefit -- The increase in signal-to-noise ratio when the FM signal is added to, or substituted for, the signal from the aid's or CI's own microphone. (see Signal-to-Noise Ratio).

FM Transmitter -- The device that transmits the radio signal that carries the sound signal. Sometimes the microphone and transmitter are incorporated into a single unit.

FM Transparency --The condition in which equal inputs to the FM and hearing aid microphones produce equal outputs from the hearing aid. (Operationally defined, here, for an input of 65 dB SPL).

Frequency Modulation (FM) -- A method by which a radio signal is used to carry a sound signal. Essentially, the frequency of the radio signal is changed (modulated) in step with the pressure variations of the sound signal.

Induction loop -- A loop of wire that is connected to the output of an amplifier. The current flowing through the wire is in step with the speech signal and generates a fluctuating magnetic field. A telecoil in the hearing device detects the fluctuations and passes them directly to the hearing device's amplifier. Note that a loop system differs from FM and Infrared systems in that no wireless carrier is used.

Infrared (aka IR) -- A region of the electromagnetic spectrum that is just below the visible region. Infrared waves are essentially very high frequency radio waves and can be used as a carrier wave in a remote-microphone system. Infrared is commonly used as a carrier in remote controls for TVs and VCRs.

Input -- The signal entering the microphone of a hearing aid, a cochlear implant or an FM system. Input level is typically specified in dB SPL.

Osseointegrated auditory implant -- BAHA (bone anchored hearing aid): a surgically implanted titanium fixture osseointegrates with the skull behind the ear, and interfaces with an external sound processor. Sound is transmitted directly through the jaw and skull bones to the inner ear, bypassing the outer and middle ear.

Osseointegration -- the ability of living tissue to integrate with titanium

Output Limiting -- A process for preventing the decibel level of the output of an amplification system from exceeding a predetermined level.

Output --The signal leaving the amplification system. It may be measured in the ear canal of a listener or in a test coupler intended to mimic an average ear. (see Real-Ear Measurement).

Real-Ear Measurement -- Measuring the output of a hearing aid in the listener's ear (see Output).

Receiver --The device that detects the wireless signal, extracts the speech signal, and passes it on to the hearing aid or other hearing device. The receiver may be a separate unit or may be built into the hearing device.

Remote microphone hearing assistance technology (RMHAT) -- A microphone is placed close to the talker's mouth where the decibel level of the acoustic speech signal is well above that of interfering noise and reverberation. The resulting high quality signal is delivered to the listener via:

Personal HAT such as FM or infrared receiver

Sound field loudspeaker

Induction loop receiver

Shoe (aka boot) -- an adapter that is placed on a hearing aid to permit the connection of FM receivers or other accessories.

Signal-to-Noise Ratio (SNR) -- The amount in decibels by which the amplitude of the desired signal (usually speech) exceeds that of an interfering signal.

Sound Field Amplification -- A hearing assistance technology in which the sound from a remote microphone is delivered to the listener via one or more judiciously placed loudspeakers. A desktop (or personal) sound-field system uses one loudspeaker placed close to the individual who needs the assistance.

Telecoil (aka T-coil) -- A feature of some (but not all) hearing aids that detects fluctuating magnetic fields, converts them to fluctuating voltage, and passes them to the amplifier of a hearing device. Originally developed to facilitate telephone use, the telecoil can also be used as the receiver in a remote-microphone loop system.

Verification – the objective testing of how the RMHAT system is working with the child's personal amplification equipment, to ensure that the combined unit is programmed and functioning as intended,

prescribed gain and output characteristics are preserved, and (in the case of FM systems) the appropriate FM advantage is achieved.

Verification procedures - The specific procedures implemented for verification will vary depending on the listener and the type of RMHAT system selected. Testing should include electroacoustic, real-ear, and/or behavioural measures as appropriate.¹⁹ (see definitions for Behavioural Evaluation, Electroacoustic Evaluation, and Real-Ear Measurement).

Validation – This is a demonstration of the benefits and limitations of the recommended RMHAT device; it is an ongoing process that begins immediately after fitting and verification, and is designed to ensure that the child/youth is receiving optimal speech input from others and that his or her own speech is adequately perceived. Validation procedures should occur in and reflect the typical listening environment experienced by the child/youth.

Validation tools - Typical validation tools include self-assessments, observation questionnaires, and functional evaluations conducted with the child/youth in their learning environment (functional outcome measures). They also include regular listening checks to monitor and ensure that the child's equipment is working properly.²⁰

REFERENCES

- 1 ASHA 2002: Preselection, p. 4
- 2 AAA 2008: RMHAT Candidacy, Implementation and Device Selection
- 3 ASHA 2002: Personnel p. 3
- 4 AAA 2008: 3. Personnel Qualifications
- 5 CASLPO Preferred Practice Guidelines
- 6 AAA 2008: 6. Fitting and Verification Procedures
- 7 ASHA 2002: Personnel p. 3
- 8 AAA 2008: 3. Personnel Qualifications
- 9 AAA 2008: 7. Implementation and Validation Procedures
- 10 ASHA 2002: Management – Monitoring p. 5
- 11 AAA Supplement SA1.3 Ear-level FM verification procedures
- 12 AAA Supplement SA1.6 Electroacoustic Verification Steps
- 13 ASHA 2002 reference to verification procedure for “self contained FM system, in which the FM receiver and amplifier are in a single unit”. FM advantage can be set in FM Successware.
- 14 AAA Supplement SA2. Group 2: Children and Youth wearing Cochlear Implants
- 15 Cochlear Corporation 2009, Phonak 2009
- 16 AAA Supplement SA3. Group 3:
- 17 Anecdotal information from contributing audiologists has identified situation with excessive ear canal sound pressure level.
- 18 AAA Document, Appendix C
- 19 AAA 6. Fitting and Verification procedures
- 20 AAA 7.2 Validation procedures, and 7.3 Monitoring Procedures